

ARB-TDA REPORT NO. 50-78

REPORT ON AN AMBIENT AIR SURVEY

IN

TERRACE BAY

(Kimberly-Clark of Canada, Limited)

September, October, November, 1977

JUNE, 1978



Ontario

Ministry
of the
Environment

The Honourable
George R. McCague,
Minister

K.H. Sharpe,
Deputy Minister

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Technology Development and Appraisal Section
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ARB-TDA Report No. 50-78

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(Kimberly-Clark of Canada, Limited)

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Ontario Ministry of
the Environment,
880 Bay Street,
Toronto, Ontario.

JUNE, 1978

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01. SUMMARY

An ambient air monitoring survey was carried out in the town of Terrace Bay during the fall of 1977. The main aim of this survey was to monitor selected pollutants in the vicinity of the Kimberly-Clark of Canada, Limited mill located approximately 2 km to the north of this community.

Predominantly light northerly winds and clear, calm atmospheric conditions prevailed throughout most of the survey period. "Land breezes" and "Nocturnal Inversions" were essentially the only two meteorological phenomena that gave rise to any appreciable ground level concentrations of the selected pollutants.

A significant construction/expansion programme was being undertaken at this mill during the survey period.

Over 220 hours of data were accumulated and analyzed during this survey.

Due to their location and potential impact on the environment, two sources were considered during the assessment of the total reduced sulphur (TRS)* concentration data. These sources were the kraft pulp mill and the mill effluent ditch (refer to Map #1, sources identified by "x" and "y" respectively, page 7).

Referring to the mill area only, the overall average concentration of TRS for the entire survey period was 0.014 ppm with an associated standard deviation of 0.013 ppm. However, the maximum 30-minute average concentration of total reduced sulphur (TRS) was 0.077 ppm.

* Because the analyzer was sensitive to H₂S and mercaptans and to other malodorous sulphide compounds, the results were reported as Total Reduced Sulphur (TRS) and expressed as concentrations of hydrogen sulphide.

and the maximum instantaneous concentration was 0.243 ppm. Twenty-two of the 200 hours of TRS data acquired pertaining to this source resulted in 30-minute average concentrations in excess of 0.027 ppm (Province of Ontario guideline).

In addition, 13 of the 27 hours of monitored TRS data acquired at the first mill effluent ditch crossing, on highway #17 resulted in 30-minute average concentrations in excess of 0.027 ppm (TRS guideline). The maximum 30-minute average and instantaneous concentrations of TRS recorded at this site were 0.54 ppm and 1.40 ppm respectively.

Very little sulphur dioxide (SO_2) was detected during this survey. The overall average concentration for the entire survey period was 0.007 ppm with an associated standard deviation of 0.006 ppm and the average of the maximum 30-minute average concentrations was 0.012 ppm. (The 30-minute point of impingement standard for SO_2 is 0.3 ppm.) With respect to the mill area survey, no apparent increase in SO_2 concentration levels were detected at the first mill effluent ditch crossing on highway #17. The maximum 30-minute average concentration of SO_2 detected during the entire survey was 0.035 ppm.

Very little ozone (O_3) was detected during this survey. The overall average concentration of this pollutant during the entire survey period was 0.021 ppm with an associated standard deviation of 0.007 ppm. The maximum 30-minute average concentration observed during the entire survey was 0.051 ppm. This compares with 30-minute standard of 0.100 ppm.

The overall average concentration of the oxides of nitrogen (NO_x) for the entire survey period was 0.10 ppm with an associated standard deviation of 0.12 ppm. The 1/2 hour point of impingement standard of 0.27 ppm was exceeded during 23 of the 220 hours of survey data (during 5 of the 34 survey periods). The maximum 30-minute average concentration recorded was 0.780 ppm and this relatively high concentration was detected under light winds (less than 10 km/hr) on highway #17 near the Aguasabon River bridge, west of Terrace Bay. The wind-rose analyses for this period showed the Kimberly-Clark mill as the source of this pollutant.

Forty-seven samples of total suspended particulate matter (TSP) were collected by a network of five Hi-Volume samplers located in the vicinity of this mill during the period September 30th to October 10th inclusive. The overall average concentration of total suspended particulate for this monitoring programme was 30 ug/m^3 , with an associated standard deviation of 30 ug/m^3 . Only one of the samples was found to have total suspended particulate loadings in excess of 120 ug/m^3 (Ontario Air Quality Criterion), this being 142 ug/m^3 and it was collected at #254 Kenogami Street under essentially calm atmospheric conditions.

These 47 Hi-Volume samples were also analysed for sulphates ($\text{SO}_4^{=}$), chlorides (Cl^-), free carbon (mainly coal, coke and graphite) and total carbon (free carbon plus carbonates and organic compounds). Very little of these contaminants were found in any of the collected samples.

In conclusion, this survey found that Kimberly-Clark mill was a source of reduced sulphur compound emissions which, from time to time, resulted in ambient air concentrations in excess of the Ministry's guideline of 0.027 ppm (27 ppb). A stronger source of reduced sulphur was the mill's effluent ditch, in the vicinity of which the concentrations exceeded up to 20 times the 0.27 ppm guideline.

The mill was also found to be a source of nitrogen oxides, which were occasionally detected at concentrations exceeding the 30-minute standard of 0.27 ppm at the point of impingement.

Concentrations of sulphur dioxide and ozone at the points of impingement were within the regulations as set by the Environmental Protection Act, 1971, of the province of Ontario. Except for one occasion, concentrations of total suspended particulate matter were also found to be within the regulations set by this Act.

02. INTRODUCTION

As requested by the Northwestern Region, the Monitoring and Instrumentation Development Unit of the Air Resources Branch conducted an ambient air pollution survey in the town of Terrace Bay during September, October and November, 1977.

Total reduced sulphur and sulphur dioxide were the pollutants of major interest originating from the kraft pulp mill owned by Kimberly-Clark of Canada, Limited.

In addition to these and other gaseous pollutants routinely monitored during a survey, the Northwestern Region requested information regarding the identification and concentrations of total suspended particulate matter (TSP) in the vicinity of this mill. A Hi-Volume sampler network was set up to perform this task.

03. SOURCE DESCRIPTION

The Kimberly-Clark kraft pulp mill is located approximately 2 km north of the town of Terrace Bay on the north shore of Lake Superior. In addition, a man-made effluent ditch, originating from this kraft pulp mill, ran in a northeasterly direction and intersected Highway #17 approximately 4 km northeast of Terrace Bay. This ditch eventually joined a natural water system which intersected Highway #17 two more times and eventually flowed into Lake Superior.

At the time of this study, a significant expansion programme was being undertaken. The construction included installation of new recovery furnace, power boiler and lime kiln facilities and their associated stacks. During the survey period, the old recovery furnace, power boiler and lime kiln facilities were on-line and operational. In addition and with respect to the newer facilities, only intermittent operation of the new lime kiln was being carried out.

Because of the flat terrain of the area, very little orographic wind modification/interaction was observed at this locale.

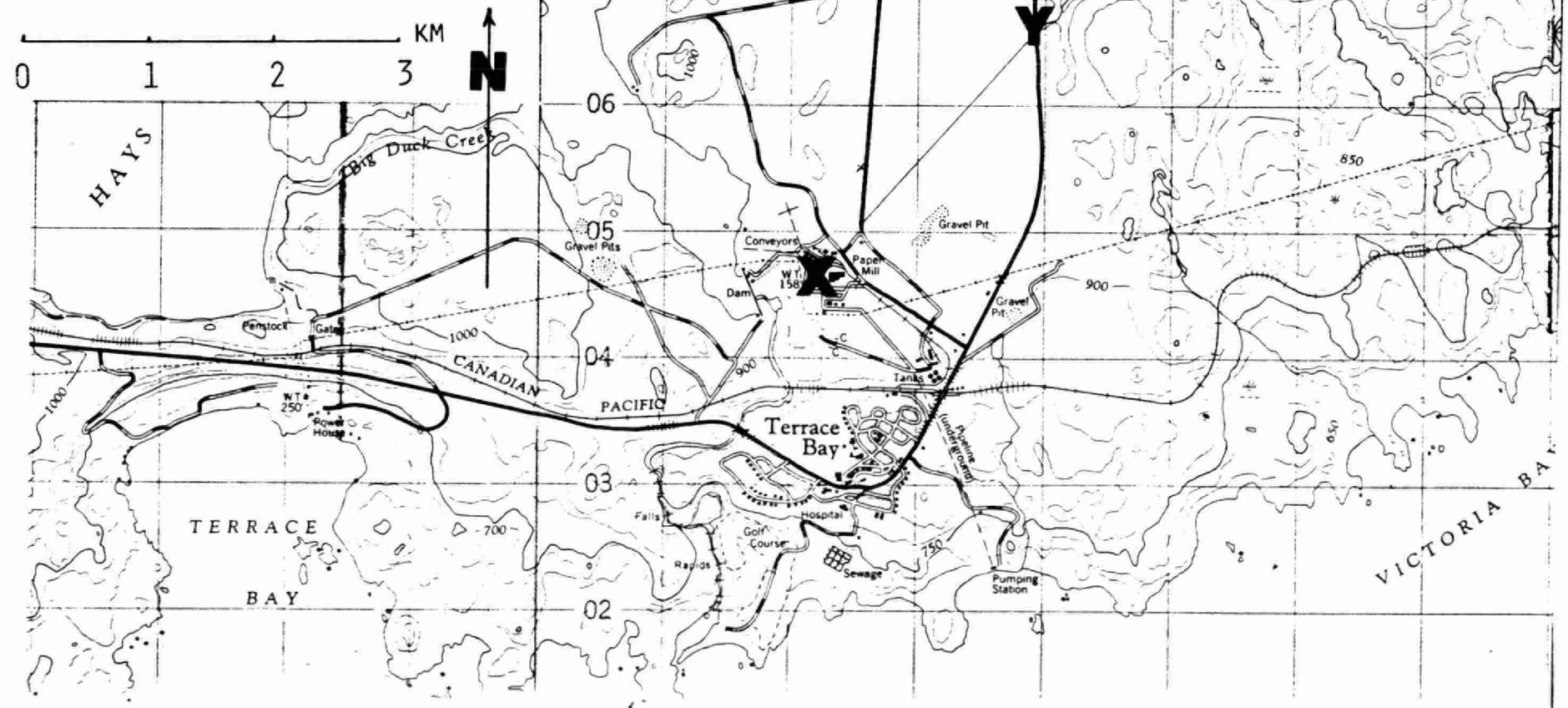
The mill and the surrounding area are shown in Map #1,

KIMBERLY-CLARK OF CANADA LIMITED
TERRACE BAY, ONTARIO

SOURCE

OLD POWER BOILER STACK (X)
(49220-56047)

EFFLUENT DITCH - CROSSING #1 (Y)
(49385-54066)



04. SURVEY TECHNIQUE

Two mobile air monitoring units, a 1971 Ford Econoline SP-200 van and a 1975 General Motors Corporation Transmode, were utilized to monitor the emissions from the Kimberly-Clark Pulp & Paper Company Limited mill. Both units were equipped with automated data acquisition systems (Ford - Hewlett & Packard 3480 system and the GMC - Hewlett & Packard 9830A mini-computer system) and on-board electric generators (Ford - 3.5 kW and GMC - twin 6 kW). Automated, independent and continuous monitoring capabilities were a major feature of these units. The HP 9830A mini-computer system performed initial data analyses in the field (re: accuracy and validity) but the final data reduction and analyses were carried out by a larger system located within the Air Resources Branch at 880 Bay Street, Toronto.

Each unit had permanently installed analyzers for monitoring of sulphur dioxide, carbon monoxide, hydrogen sulphide, total hydrocarbons, methane, and oxides of nitrogen.

Following an assessment of wind-direction and wind-speed, the approximate location of maximum ground level concentration (glc) impingement zones was found and ambient air monitoring was initiated within these areas. Air quality was continuously monitored for at least one hour at each location, and whenever possible, farther downwind monitoring was undertaken.

Five standard Hi-Volume samplers were used for monitoring of the mass of the Total Suspended Particulate Matter (TSP). They were located at several distances and directions from the sources investigated. Glass-fibre filters were used as collection media and the collected samples of TSP were also analyzed for chlorides, sulphates, and total and elemental carbon.

05. MONITORING TECHNIQUE

Sample Collection -

The ambient air samples were taken at a constant flow rate (approximately 0.2 cubic metres/min) by probes located on the vans from a point approximately 5 m above ground level. Air samples entered a manifold where each analyzer was parallel tapped with a minimal length of teflon sampling line. This arrangement ensured little or no sample degradation, minimal response time and minimal sample contamination due to ground level sources (e.g., entrained soil, vehicular traffic, etc.).

Instrumentation -

The instruments associated with each monitoring unit are presented in Tables 1 & 2, pages 11 & 12.

As stated at the end of Section 04, five Hi-Volume samplers were utilized during the survey. All samplers were operated for 24-hour periods. TSP loadings and subsequent chemical analyses were determined at the Ministry's central laboratory in Toronto.

Meteorological Analyses -

Meteorological conditions were monitored on a continuous basis by the instrumentation associated with the GMC Mobile Air Monitoring (MAM) unit (reference Table # 2, page 12). No meteorological data were collected by the Ford MAM unit but since the survey status was a microscale phenomenon, and since both units were in close proximity, the GMC data were found to be more than sufficient. Complementing this microscale monitoring, macroscale information regarding air mass movements and prognostics was obtained from the Thunder Bay weather office.

Calibration -

Analyzers and sources were calibrated before the survey. During the survey, the analyzers' calibration was checked at least once every day using the sources and built-in electronic circuitry.

All monitors were found to be extremely stable and the calibration remained within the prescribed limits throughout the duration of the survey. Immediately following completion of this survey, all instruments were rechecked in the laboratory and all calibration statistics were found to be satisfactory.

TABLE 1: INSTRUMENTATION - FORD

Instrument	Manufacturer	Analytical Technique	Maximum Sensitivity (full scale)
H ₂ S Source	Hartmann & Braun (H&B Prüfgasgenerator)	N/A	N/A
*H ₂ S Analyzer	H&B Picos	electrochemical	0.05 ppm
SO ₂ Source	H&B Prüfgasgenerator	N/A	N/A
SO ₂ Analyzer	Wösthoff oHG Ultragas - 3	conductivity	1 ppm
O ₃ Analyzer and Source	Dasibi 1003 - PC	Ultra-violet absorption	1 ppm
NO ₂ Source NO _x , NO ₂ , NO analyser	Bendix 8101-B	chemiluminescent	0.5 ppm
CO Analyzer	H&B Uras 2T	Infrared absorption (NDIR)	50 ppm
THC, CH ₄ , THC-CH ₄ Analyzer	Ingenieur - Produktions-Gruppe-München (IPM) RS-5	Dual Flame - ionization detector	50 ppm THC (as CH ₄)
CO/THC, THC-CH ₄ , CH ₄ Source	Matheson	Compressed gas	N/A

*See Table 2.

TABLE 2: INSTRUMENTATION - GMC

Instrument	Manufacturer	Analytical Technique	Maximum Sensitivity (Full Scale)
H ₂ S Source	Hartmann & Braun (H&B Prüfgasgenerator)	N/A	N/A
H ₂ S Analyzer *	H&B Picos	electrochemical	0.05 ppm
SO ₂ Source	H&B Prüfgasgenerator	N/A	N/A
SO ₂ Analyzer	H&B Picoflux 2	conductometric	0.3 ppm
O ₃ Analyzer/Source	Bendix 8002	chemiluminescent	0.05 ppm
NO _x , NO ₂ , NO Analyzer	Bendix 8101-B	chemiluminescent	0.5 ppm
CO Analyzer	H&B Uras 2T	Infrared Absorption	50 ppm
THC, CH ₄ , THC-CH ₄ Analyzer	Ingenieur - Produktions-Gruppe München (IPM) RS-5	Dual flame ionization detector	50 ppm THC (as CH ₄)
Hg Analyzer	Scintrex HGP-2	Ultra-violet Absorption	200 ng/m ³
CO, THC, THC-CH ₄ , CH ₄ source	Matheson	compressed gas	N/A
Hydrocarbons chlorinated hydrocarbons, PAN, etc. Analyzer	Hewlett & Packard Gas Chromatograph 5830A System	Retention time as measured by electron capture, thermal conductivity, or flame ionization detectors	As set by calibration procedure.

Instrument	Manufacturer	Scale
**Wind Speed	Lambrecht gmbH	km/hr
**Wind Direction	Lambrecht gmbH	degrees
Temperature	Weather Measure (WM) T621	°C
Relative Humidity	WM-HM-111P	percentage
Barometric Pressure	WM-BM70-B242	millibars
Solar Radiation	WM Star Pyranometer	watts/cm ²

* Because the analyzer was sensitive to H₂S and mercaptans and to other malodorous sulphide compounds, the results were reported as Total Reduced Sulphur (TRS) and expressed as concentrations of hydrogen sulphide.

** These wind indicators are located on top of a 10 metre retractable mast.

06. MONITORING SITE LOCATIONS

Ambient air monitoring sites are shown on Map #2 (page 14 and the associated descriptions are presented in Table #3 (pages 15 and 16). Hi-volume sampler monitoring sites are shown on Map #3 (page 17) and the associated descriptions are presented in Table #4 (page 18).

All monitoring sites were referenced to the old power boiler stack located at the south-west side of this mill (UTM - military co-ordinates 49220 - 54047).

KIMBERLY-CLARK OF CANADA LIMITED TERRACE BAY, ONTARIO

MONITORING SITES

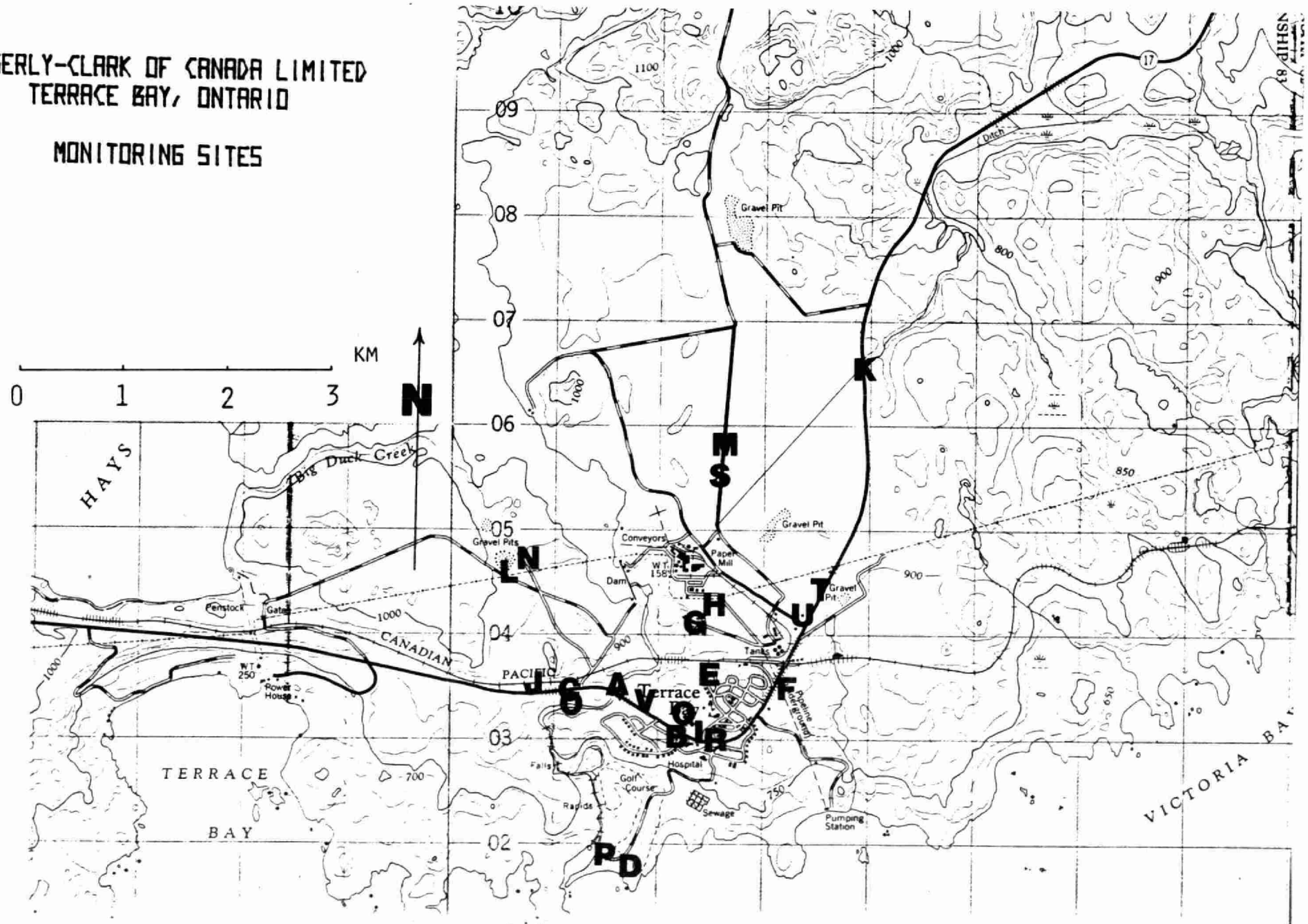


TABLE # 3

MOBILE AIR MONITORING SITES

All monitoring sites were logged as

Terrace Bay # X

Site (#x)	Map Identification	Location & UTM Co-ordinates	Distances & Bearing from source		Date
			(km)	(degrees)	
1	A	Bridge W of T.B. 49160-54034	1.4	210	Sept 29
2	A	Bridge W. of T.B. 49160-54034	1.4	210	Sept 30
3	A	Bridge W. of T.B. 49160-54034	1.4	210	Sept 30
5	B	Hwy #17 & Selkirk Ave. 49220-54031	1.7	180	Oct 1
6	C	Hwy #17, W. of T.B. 49120-54035	1.6	225	Oct 1
7	C	Hwy #17, W. of T.B. 49120-54035	1.6	225	Oct 1
8	D	S. of Golf Club 49170-54017	3.1	190	Oct 2
10	D	S. of Golf Club 49170-54017	3.1	190	Oct 2
11	D	S. of Golf Club 49170-54017	3.1	190	Oct 2
13	D	S. of Golf Club 49170-54017	3.1	190	Oct 2
14	E	#169 Birch St. 49250-54036	1.1	170	Oct 3
15	E	#169 Birch St. 49250-54036	1.1	170	Oct 4
16	F	Shell Station 49320-54035	1.6	135	Oct 14
17	G	Mill Rd. (Cemetery) 49220-54042	0.4	180	Oct 15
18	G	Mill Rd. (Cemetery) 49220-54042	0.4	180	Oct 15
19	H	Mill Rd. 49240-54042	0.7	170	Oct 15
20	I	Sports Centre 49230-54030	1.8	170	Oct 15
21	J	Hwy #17, W. of T.B. 49080-54035	2.0	220	Oct 16
22	K	Crossing # 1 49385-54066	2.5	040	Oct 16
23	L	Mill Rd. (west) 49050-54067	2.3	315	Oct 17

TABLE # 3 CONT'D

Site (#x)	Map Identification	Location & UTM Co-ordinates	Distances & Bearing from source (km)	Bearing (degrees)	Date
25	M	Mill Rd. (east) 49260-54058	1.2	030	Oct 17
26	N	Logging Rd (west) 49070-54062	2.1	325	Oct 17
27	K	Crossing # 1 49385-54066	2.5	040	Nov 7
28	O	Hwy #17 & Aguasabon Rd. 49125-54035	1.8	215	Sept 30
29	G	Mill Rd. (Cemetery) 49220-54042	0.4	180	Sept 30
30	G	Mill Rd. (Cemetery) 49220-54042	0.4	180	Sept 30
31	P	Beach (Lake Superior) 49160-54018	3.1	195	Oct 1
32	A	Bridge W.of T.B. 49160-54034	1.4	210	Oct 2
33	Q	Rec.Centre Parking Lot 49250-54031	1.8	186	Oct 2
34	R	Imperial Motel 49225-54030	1.9	175	Oct 2
37	S	Mill Rd.(east) 49260-54055	0.8	030	Oct 5
38	T	Hwy #17 & Gravel Pt. 49365-54047	1.4	100	Oct 5
39	T	Hwy #17 & Gravel Pit 49365 - 54047	1.4	100	Oct 5
40	U	Texaco Station 49345-54042	1.3	135	Oct 5
41	R	Imperial Motel 49225-54030	1.9	175	Oct 3
42	V	Min. Nat. Res. 49190-54034	1.6	200	Oct 11

NOTE: In this table the Transmode MAM units' locations were presented first (Sites # 1 to # 27 inclusive) and the Ford's locations were presented as Sites #28 to #42 inclusive. The locations were presented in chronological order, however some omissions were made. These omissions were based on invalid/insufficient data or data that were logged solely for calibration statistics.

KIMBERLY-CLARK OF CANADA LIMITED
TERRACE BAY, ONTARIO

HI-VOL SITES

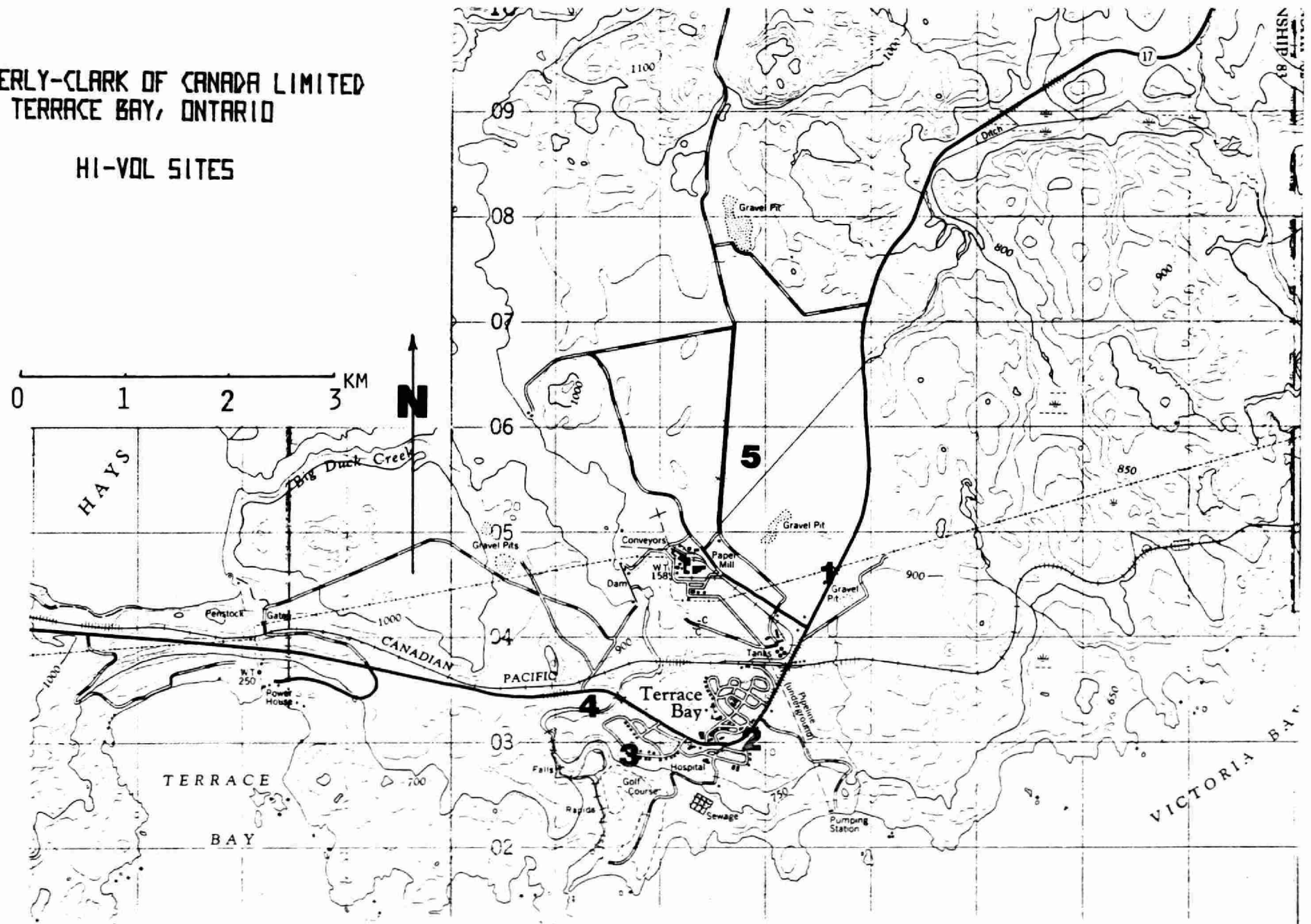


TABLE #4

Hi-Volume Samplers - Site Description

Site #	Location and UTM Coordinates	Distance & Bearing from Source
#1	Ministry of Transportation and Communications, Hwy #7, 2 km E of T.B. (M.T.C.) 49355-54046	1.4 km & 100 dgs
#2	254 Kenogami Street (254 K.) 49290-54032	1.7 km & 160 dgs.
#3	533 Lakeview Rd. (533 L.) 49165-54028	1.8 km & 205 dgs.
#4	Aguasabon Falls Campground (A.F.C.) 49145-54034	1.5 km & 215 dgs.
#5	Kimberly-Clark Airfield (K.C.A.) 49295-54057	1.4 km & 080 dgs.

Note: Abbreviations are used in Table # 8 , page 33 to 36.

07. RESULTS

Definition of Terms -

Scanning Time: Frequency of interrogation of the monitoring instrumentation by the Data Acquisition Systems.

Time: Time of first and final scans used to determine running averages.

Number of Readings: Number of scans.

MAM: Mobile Air Monitoring

MAC: Maximum Average Concentration

All statistical values are based on instantaneous recorded values and all results are expressed in parts per million (ppm). An example of the processed data format incorporated in this survey report is presented in Table #5 (page 20). Due to the voluminous nature of these data, a special addendum to this report entitled, "Ambient Air Survey in Terrace Bay - 1977; Compilation of Time Averaged Data", will accompany this report and will be presented upon request.

Although total reduced sulphur (TRS) and sulphur dioxide (SO_2) were the gaseous pollutants of primary interest, ozone (O_3) and the oxides of nitrogen (NO_x , NO_2 , NO) were also monitored throughout this survey. These results are presented in Tables #6 and 7 (pages 27 to 32 inclusive). Supplementing these tables of statistical results, concentration versus time graphs for TRS SO_2 , NO_x and O_3 are presented in Figures #1 to 14 (pages 38 to 51 inclusive).

In order to identify total reduced sulphur and oxides of nitrogen source locations, wind-rose/concentration analyses were also performed (reference Maps #4 to #8 - pages 52 to 56 inclusive).

In addition to these gaseous pollutants, total suspended particulate matter (TSP) data were also accumulated. The analyzed data are presented in Table #8, pages 33 to 36 inclusive.

TABLE #5
Processed Data Format
Terrace Bay #5

(Further Analyses are Presented as an
Addendum to This Report)

TERRACE BAY #5

DATE: OCT 1 1977
SCAN TIME: 60 SEC
AVERAGING TIME: 30 MIN
LOCATION: HWY #17 & SELKIRK AVE. (49220-54031); 1.7 KM & 180 DEG / SOURCE

TIME	CO THC-CH4 NO TEMP WIND DIRECTION	TRS CH4 HG HUMIDITY	THC NOX OZONE BAROMETER	S02 NO2 SOLAR RAD WIND SPEED
13:11----13:41	1.1E+00 8.3E-01 1.4E-01 13 37	1.0E-02 2.4E+00 2.4E-02 39	2.8E+00 1.5E-01 3.0E-02 990	1.6E-03 1.5E-02 6.0E-02 15
13:26----13:56	1.3E+00 7.6E-01 1.1E-01 13 42	9.6E-03 2.3E+00 3.0E-02 39	2.7E+00 1.1E-01 3.1E-02 990	1.2E-03 1.1E-02 6.0E-02 18
13:41----14:11	1.2E+00 3.3E-01 4.2E-02 13 42	9.0E-03 1.4E+00 3.2E-02 39	1.5E+00 3.3E-02 3.1E-02 989	1.2E-03 3.8E-03 5.9E-02 15
13:56----14:26	1.4E+00 4.1E-01 9.1E-02 14 44	1.3E-02 1.5E+00 3.2E-02 38	1.7E+00 1.0E-01 3.1E-02 989	1.4E-03 1.5E-02 5.9E-02 13

STATISTICS

NUMBER OF READINGS 78

POLLUTANT	MINIMUM VALUE	MAXIMUM VALUE	ARITHMETIC MEAN	STANDARD DEVIATION	GEOMETRIC MEAN	GEOMETRIC STD. DEV.
CO	1.00E-06	3.26E+00	1.25E+00	4.97E-01	4.46E-01	4.41E+01
TRS	5.16E-03	2.29E-02	1.15E-02	4.00E-03	1.09E-02	1.37E+00
THC	3.68E-02	3.81E+00	2.29E+00	9.82E-01	1.51E+00	3.97E+00
S02	8.52E-04	2.42E-03	1.41E-03	3.31E-04	1.38E-03	1.24E+00
THC-CH4	1.00E-06	3.52E+00	6.13E-01	4.32E-01	2.07E-01	2.55E+01
CH4	4.62E-02	2.44E+00	2.00E+00	7.83E-01	1.45E+00	3.28E+00
NOX	1.00E-06	3.12E-01	1.17E-01	9.34E-02	3.74E-03	2.47E+02
NO2	1.00E-06	1.10E-01	1.40E-02	1.92E-02	1.48E-03	4.50E+01
NO	7.90E-05	2.98E-01	1.11E-01	8.22E-02	3.34E-02	1.08E+01
HG	1.00E-06	3.14E+00	6.79E-02	3.52E-01	2.52E-02	3.76E+00
OZONE	2.54E-02	3.27E-02	3.05E-02	1.31E-03	3.05E-02	1.05E+00
SOLAR RAD	5.80E-02	6.02E-02	5.93E-02	5.97E-04	5.93E-02	1.01E+00
TEMP	11	14	13	0		
HUMIDITY	0	41	38	4	31	7
BAROMETER	989	990	989	0	989	1
WIND SPEED	4	35	16	6	15	2

08. DISCUSSION:

Predominantly light northerly winds and stagnant atmospheric conditions prevailed throughout most of the survey period. This locale was often under the influence of high pressure systems (usually Continental air mass) and the light northerly winds were often directly attributable to the "land breeze" effect that is often observed in the fall season when the land mass is much cooler than the surrounding water bodies (Lake Superior). The average wind speeds experienced throughout the daytime periods were often less than 10 km/hr whereas the winds reported during the early morning hours were often in excess of 20 km/hr. Terrace Bay #16 on October 14 was a very good example of these meteorological conditions (Figure #7 concentration/time graph, page 44).

Because of the calm, clear atmospheric conditions, nighttime radiation cooling and the subsequent build-up of a low-level nocturnal inversion layer were often observed. This second phenomenon helped to diminish the early morning "land breeze" effect and also, the subsequent radiation fog trapped low-level emissions from the mill area. Site survey Terrace Bay #7 was a very good example of this phenomenon. (Figure #5 , page 72). Following the "burnoff" of the fog, usually by mid-morning, good atmospheric dispersion was often observed and ground-level ambient air monitoring resulted in low concentrations for the pollutants of interest. Only during nighttime monitoring, as a direct result of the aforementioned atmospheric conditions, appreciable ground-level concentrations of the pollutants were measured.

Total Reduced Sulphur (TRS) - expressed as hydrogen sulphide

The analyzers used in the mobile air monitoring

units were also sensitive to the mercaptans and compounds containing the HS^- group. Since hydrogen sulphide was the predominant compound, all results were expressed as concentrations in terms of hydrogen sulphide.

Monitoring of TRS was carried out at every site during this survey and a summary of the results is presented in Table #6, pages 27 to 29. As mentioned in the Summary, two sources were considered for this pollutant and the results are presented accordingly.

i) Kraft Pulp Mill

Thirty-four of the thirty-six reported survey periods resulted in total reduced sulphur concentration data pertaining to the emissions from this source. For these periods, the overall average concentration of total reduced sulphur was 0.014 ppm with associated standard deviation 0.013 ppm. The overall average concentration of the maximum 30-minute average concentrations (MAC)* of total reduced sulphur was 0.020 ppm with associated standard deviation 0.016 ppm.

Twenty-two of the 200 hours of data acquired pertaining to this source (during 11 of the 34 survey periods) resulted in 30-minute average concentrations of total reduced sulphur in excess of 0.027 ppm. Reported surveys during September 30th (i.e., Terrace Bay #'s 1, 2 and 3) were excellent examples of these high concentrations. The winds were approximately 10 km/hr from the northeast and the Transmode MAM unit was located directly downwind of the kraft pulp mill. Concentration/time analyses for these three survey periods (Figures #'s 1, 2 and 3) and the wind-rose analyses of Terrace Bay #3 (Map #4) showed the time variation of the total reduced sulphur concentration and directly pointed to the kraft pulp mill as being the only possible source. In addition, survey periods Terrace Bay #'s 6, 14, 18, 20, 25 and 30 gave similar results.

* For definition of terms see Section 07; Results

The TRS ambient air concentrations, based on 30-minute averages, acquired during the survey period Terrace Bay #37 were the maximum reported values obtained throughout the entire survey. The maximum 30-minute MAC and instantaneous concentrations of TRS were 0.077 ppm and 0.243 ppm respectively. These concentrations were obtained under essentially calm atmospheric conditions (wind speed less than 5 km/hr) and the MAM unit was located 0.8 km northeast of the kraft pulp mill.

- ii) Mill Effluent ditch - Crossing #1
approximately 4 km northeast of
Terrace Bay.

Of the 27 hours of reported data for this site, the total reduced sulphur guideline of 0.027 ppm was exceeded during approximately 50% of the time (i.e.; 13 hours). Surveys Terrace Bay #'s 22 and 27 show the ambient air concentration of gaseous pollutants originating from this source. The highest maximum 30-minute average concentration of total reduced sulphur was 0.540 ppm and this value may be directly attributable to the emissions from the ditch, coupled with the poorer dispersion conditions associated with the nocturnal inversion. The survey, Terrace Bay #27, shows the gradual build-up of gaseous pollutants, including total reduced sulphur during the early morning hours. The wind-rose analyses for this site should only serve as an indication since the directional reliability of the wind vane is reduced at very low wind speeds (≤ 5 km/hr).

The maximum instantaneous concentration of 1.4 ppm was also recorded during this survey period (i.e., Terrace Bay #27).

Sulphur Dioxide (SO_2):

Monitoring of sulphur dioxide was carried out during every monitoring period and a summary of the analyzed data is presented in Table #6, pages 27, 28 and 29).

Very low concentrations of sulphur dioxide were detected. The overall average concentration for the entire survey period was 0.007 ppm with associated standard deviation of 0.006 ppm.

The overall average of the maximum 30-minute average concentrations of sulphur dioxide was 0.012 ppm and the associated standard deviation was 0.010 ppm. Even at site Terrace Bay #27, the reported sulphur dioxide concentration values were extremely low (0.005 ppm for the maximum 30-minute average concentration). The highest maximum 30-minute average concentration was 0.037 ppm and this value was recorded on October 15th during northerly winds when the MAM unit was approximately 400 meters south of the old power boiler stack. (The Ontario Environmental Protection Act, 30-minute standard for sulphur dioxide at the point of impingement is 0.300 ppm.)

Ozone (O_3):

Ozone was detected in low concentrations during the survey and a summary of the analyzed data is presented in Table #7; pages 30 to 32. The overall average of ozone for the entire survey period was 0.021 ppm with associated standard deviation 0.007 ppm. The highest maximum 30-minute average concentration was 0.051 ppm and was detected during the monitoring of Terrace Bay #16 on October 14th. (30-minute standard for ozone is 0.100 ppm).

Oxides of Nitrogen (NO_x):

The oxides of nitrogen were also monitored and a summary of the analyzed data is presented in Table #7, page 30 to 32.

The overall average concentration and associated standard deviation of oxides of nitrogen for the entire survey period were 0.104 ppm and 0.123 ppm respectively. The overall average of the 30-minute MAC was 0.165 ppm with associated standard deviation of 0.176 ppm.

The highest concentration of NO_x was detected on September 30th during the monitoring period between 11:42 and 16:27 hours (Terrace Bay #2). The instantaneous maximum value recorded during this time was 1.88 ppm and the maximum 30-minute average concentration was 0.789 ppm. Wind-rose analyses for this period (Map #8) clearly show the Kimberly-Clark kraft pulp mill as the source.

High oxides of nitrogen concentrations were often recorded during nighttime monitoring. The results of survey periods Terrace Bay #'s 14, 15, 16, 22 and 26 illustrate this observation. The concentration/time graph of Terrace Bay #14 shows this nighttime concentration buildup and the high oxides of nitrogen concentrations may be directly attributable to the mill emissions coupled with poorer nocturnal dispersion.

Hi-Volume Analyses:

Five Hi-Volume samplers with glass fibre filters were utilized to determine time-integrated total suspended particulate (TSP) mass loadings. This five-unit network was placed around the kraft pulp mill area (Map #3 and Table #4 contain complete site locations) and operated between September 30 and October 10 inclusive.

Forty-seven samples were collected and analyzed for total suspended particulate matter (TSP), sulphates ($\text{SO}_4^{=}$), chlorides (Cl^-), free carbon (mainly coal, coke and graphite) and total carbon (free carbon constituents plus carbonates and organic compounds). A summary of the results is presented in Table #8, pages 33 to 36 inclusive.

(i) Total Suspended Particulate (TSP):

The overall 24-hour average of TSP as analyzed from the 47 samples was 30 ug/m^3 with an associated standard deviation of 30 ug/m^3 .

Only one of the forty seven samples had TSP loadings in excess of the air quality criterion of 120 ug/m^3 and this sample was collected at 254 Kenogami Street during essentially calm atmospheric conditions on October 2 (winds were northerly but the wind speed was less than 5 km/hr).

The highest daily average loadings of TSP were recorded

from October 1st to 3rd. Analyses of the 15 collected samples resulted in daily average total suspended particulate loadings of 45 ug/m^3 , 48 ug/m^3 and 48 ug/m^3 for these respective sampling days. The winds were light and northerly during this time, and thus the sampling sites were downwind of the mill.

Of the five monitoring sites, 254 Kenogami Street was found to have the highest average loading of total suspended particulate for the entire survey. This average loading (60 ug/m^3) was found to be at least twice the average loadings acquired at the other monitoring sites. (Refer to page 36, Table 8d-Comments). The northerly winds, a direct result of the nighttime "Land Breeze" effect, were responsible for these elevated concentrations.

(ii) Sulphates ($\text{SO}_4^{=}$):

The overall average of sulphates for the 47 collected samples was 4.9 ug/m^3 . Therefore approximately 17% of the total suspended particulate was found to be composed of $\text{SO}_4^{=}$.

The maximum 24-hour concentration was 24.9 ug/m^3 and this sample was collected at the Kimberly-Clark air field (Site #5), located to the northeast of the mill. The sample was collected on October 9th under WSW winds and the kiln area was upwind of the sampling site.

(iii) Chlorides (Cl^-):

The overall average for chlorides for the 47 collected samples was 0.6 ug/m^3 . The maximum 24-hour concentration was 2.6 ug/m^3 and this sample was also collected at the Kimberly-Clark air field on October 9th.

(iv) Carbon - Total and Free:

Approximately 13% of the total suspended particulate was found to be composed of carbon. The overall average concentration of total carbon was 3.9 ug/m^3 . The maximum concentration was collected at the Kimberly-Clark air strip during October 3rd under essentially calm atmospheric conditions and the reported value was 17 ug/m^3 .

Approximately 20% of the total carbon was found to be composed of free (elemental) carbon. The overall average concentration of free carbon was 0.8 ug/m^3 and the maximum daily average was collected on October 3rd. The maximum loading of free carbon at this time was 2.3 ug/m^3 and once again it was collected at the Kimberly-Clark air field site (Site #5).

TABLE 6a

CONTAMINANT LEVELS IN Terrace Bay

UNITS PPM

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30-Minute Average Concentration		Sample Period Average Concentration		Scan Time (min.)
			SO ₂		TRS		SO ₂	TRS	SO ₂	TRS	
			Min.	Max.	Min.	Max.					
Terrace Bay # 1	Sept. 29	16:53-19:03	0.002	0.006	0.001	0.035	0.004	0.033	0.003	0.021	2.0
" " 2	30	11:42-16:27	0.001	0.031	0.009	0.044	0.012	0.031	0.007	0.019	0.5
" " 3	30	16:53-09:53	0.002	0.039	0.007	0.041	0.035	0.037	0.013	0.030	2.0
" " 5	Oct 1	13:11-14:26	0.001	0.002	0.005	0.023	0.002	0.013	0.001	0.011	1.0
" " 6	1	14:42-17:42	0.001	0.014	0.001	0.031	0.006	0.023	0.004	0.009	1.0
" " 7	1	20:25-09:05	0.001	0.005	0.002	0.021	0.003	0.018	0.001	0.016	2.0
" " 8	2	10:19-10:59	0.007	0.025	0.015	0.034	0.014	0.023	0.013	0.023	1.0
" " 10	2	11:37-16:37	0.001	0.018	0.001	0.024	0.008	0.014	0.006	0.006	1.0
" " 11	2	17:20-21:05	0.002	0.033	0.001	0.015	0.026	0.008	0.011	0.005	1.0
" " 13	2	23:58-09:28	0.001	0.004	0.001	0.016	0.003	0.014	0.001	0.011	1.0
" " 14	3	11:19-00:04	0.001	0.071	0.001	0.014	0.016	0.005	0.005	0.002	1.0
" " 15	4	02:13-04:28	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	1.0
" " 16	14	22:18-08:48	0.001	0.007	0.001	0.022	0.004	0.011	0.001	0.001	1.0
" " 17	15	09:44-10:44	0.001	0.091	0.025	0.056	0.037	0.041	0.024	0.039	0.5
" " 18	15	11:14-13:44	0.003	0.120	0.003	0.052	0.024	0.031	0.014	0.022	0.5

TABLE 6b

CONTAMINANT LEVELS IN TERRACE BAY

UNITS PPM

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30- Minute Average Concentration		Sample Period Average Concentration		Scan Time
			SO ₂		TRS		SO ₂	TRS	SO ₂	TRS	(min.)
			Min.	Max.	Min.	Max.					
Terrace Bay #19	Oct 15	15:17-16:47	0.001	0.025	0.019	0.037	0.016	0.033	0.011	0.029	0.5
" " 20	15	18:40-09:20	0.004	0.031	0.001	0.035	0.030	0.031	0.020	0.018	2.0
" " 21	16	10:49-13:04	0.004	0.008	0.007	0.026	0.007	0.018	0.006	0.013	0.5
" " 22	16	23:24-09:24	0.001	0.017	0.001	0.035	0.002	0.021	0.001	0.009	1.0
" " 23	17	13:04-15:34	0.003	0.014	0.001	0.047	0.010	0.019	0.006	0.007	1.0
" " 25	17	16:11-20:41	0.002	0.011	-	-	0.008	-	0.004	-	1.5
" " 26	17	21:34-08:49	0.001	0.004	0.001	0.014	0.001	0.004	0.001	0.001	1.5
" " 27	Nov 7	17:40-10:55	0.001	0.011	0.007	1.400	0.005	0.540	0.003	0.127	1.5
" " 28	Sept 30	11:40-13:10	0.004	0.005	0.001	0.001	0.005	0.001	0.005	0.001	1.0
" " 29	30	14:15-15:45	0.008	0.066	0.008	0.017	0.027	0.013	0.016	0.012	1.0
" " 30	Oct 1	16:30-22:15	0.005	0.028	0.002	0.031	0.011	0.027	0.007	0.019	5.0
" " 31	1	14:35-01:35	0.001	0.007	0.001	0.010	0.007	0.002	0.002	0.001	5.0
" " 32	2	10:55-07:45	0.003	0.031	0.001	0.002	0.023	0.001	0.006	0.001	10.0
" " 33	2	14:25-15:55	0.003	0.039	0.001	0.009	0.011	0.004	0.009	0.003	1.0
" " 34	2	16:25-05:55	0.001	0.029	0.001	0.021	0.015	0.018	0.003	0.012	3.0

TABLE 6c

CONTAMINANT LEVELS IN Terrace Bay

UNITS PPM

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30-Minute		. Sample Period .		Scan Time
			SO ₂		TRS		Average Concentration		Average Concentration		
			Min.	Max.	Min.	Max.	SO ₂	TRS	SO ₂	TRS	(min.)
Terrace Bay #37	Oct 5	11:07-12:07	0.004	0.006	0.022	0.243	0.006	0.077	0.006	0.055	1.0
" " 38	5	12:45-13:30	0.006	0.006	0.009	0.142	0.006	0.043	0.006	0.033	1.0
" " 39	5	16:30- 17:15	0.013	0.069	0.003	0.013	0.023	0.009	0.021	0.008	1.0
" " 40	5	22:20-07:50	0.011	0.025	0.001	0.053	0.017	0.028	0.011	0.008	3.0
" " 41	8	23:00-05:45	-	-	0.002	0.015	-	0.014	-	0.011	3.0
" " 42	11	21:25-08:40	0.001	0.003	0.006	0.023	0.003	0.020	0.002	0.008	3.0

TABLE 7a

CONTAMINANT LEVELS IN TERRACE BAY

UNITS PPM

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30-Minute Average Concentration		Sample Period Average Concentration		Scan Time (min.)
			O ₃		NO _x		O ₃	NO _x	O ₃	NO _x	
			Min.	Max.	Min.	Max.					
Terrace Bay #1	Sept 29	16:53-19:03	0.012	0.022	0.001	0.324	0.020	0.200	0.019	0.083	2.0
" " 2	30	11:42-16:27	0.008	0.029	0.001	1.880	0.025	0.780	0.022	0.488	0.5
" " 3	30	16:53-09:53	0.001	0.029	0.001	0.573	0.013	0.120	0.013	0.006	2.0
" " 5	Oct 1	13:11-14:26	0.025	0.033	0.001	0.312	0.031	0.150	0.031	0.117	1.0
" " 6	1	14:42-17:42	0.001	0.034	0.001	0.567	0.029	0.110	0.027	0.076	1.0
" " 7	1	20:25-09:05	0.003	0.031	0.001	0.228	0.029	0.190	0.022	0.014	2.0
" " 8	2	10:19-10:59	0.009	0.027	0.076	0.586	0.023	0.230	0.022	0.206	1.0
" " 10	2	11:37-16:37	0.001	0.035	0.001	0.411	0.030	0.140	0.026	0.094	1.0
" " 11	2	17:20-21:05	0.004	0.036	0.030	0.382	0.034	0.110	0.023	0.077	1.0
" " 13	2	23:58-09:28	0.001	0.027	0.001	0.224	0.026	0.160	0.021	0.067	1.0
" " 14	3	11:19-00:04	0.004	0.041	0.054	0.597	0.037	0.380	0.029	0.230	1.0
" " 15	4	02:13-04:28	0.009	0.017	0.351	0.714	0.015	0.500	0.013	0.450	1.0
" " 16	14	22:18-08:48	0.007	0.057	0.003	0.464	0.051	0.240	0.044	0.063	1.0
" " 17	15	09:44-10:44	0.010	0.020	0.007	0.050	0.018	0.025	0.017	0.021	0.5
" " 18	15	11:14-13:44	0.010	0.024	0.012	0.119	0.023	0.074	0.021	0.047	0.5

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30-Minute		Sample Period		Scan Time
			O ₃		NO _x		Average Concentration		Average Concentration		
			Min.	Max.	Min.	Max.	O ₃	NO _x	O ₃	NO _x	
Terrace Bay #19	Oct 15	15:17-16:47	0.013	0.031	0.027	0.130	0.027	0.066	0.027	0.055	0.5
" " 20	15	18:10-09:20	0.006	0.027	0.008	0.329	0.026	0.180	0.020	0.107	2.0
" " 21	16	10:49-13:04	0.001	0.014	0.007	0.171	0.012	0.094	0.007	0.037	0.5
" " 22	16	23:24-09:24	0.003	0.019	0.016	0.239	0.018	0.230	0.016	0.130	1.0
" " 23	17	13:04-15:34	0.012	0.033	0.033	0.317	0.029	0.160	0.028	0.132	1.0
" " 25	17	16:11-20:41	0.009	0.033	0.018	0.588	0.032	0.360	0.029	0.185	1.5
" " 26	17	21:34-08:49	0.002	0.026	0.030	0.643	0.021	0.640	0.018	0.446	1.5
" " 28	Sept 30	11:40-13:10	0.009	0.030	0.073	0.278	0.022	0.110	0.021	0.100	1.0
" " 29	30	14:15-15:45	0.014	0.040	0.047	0.067	0.026	0.057	0.024	0.054	1.0
" " 30	30	16:30-22:15	0.004	0.049	0.003	0.053	0.034	0.049	0.020	0.038	5.0
" " 31	Oct 1	14:35-01:35	0.001	0.039	0.013	0.060	0.025	0.060	0.020	0.038	5.0
" " 32	2	10:55-07:45	0.011	0.043	0.030	0.046	0.033	0.044	0.023	0.034	10.0
" " 33	2	14:25-15:55	0.010	0.038	0.036	0.064	0.028	0.049	0.026	0.045	1.0
" " 34	2	16:25-05:55	0.001	0.035	0.012	0.065	0.026	0.057	0.017	0.030	3.0

TABLE 7c

CONTAMINANT LEVELS IN Terrace Bay

UNITS PPM

SITE LOCATION	Date 1977	Monitored Period	Instantaneous Concentration				Maximum 30-Minute Average Concentration		Sample Period Average Concentration		Scan Time (min.)
			O ₃		NO _x		O ₃	NO _x	O ₃	NO _x	
			Min.	Max.	Min.	Max.					
Terrace Bay #37	5	11:07-12:07	0.002	0.026	0.029	0.041	0.013	0.033	0.012	0.032	1.0
" " 38	5	12:45-13:30	0.002	0.033	0.031	0.061	0.016	0.040	0.015	0.039	1.0
" " 39	5	16:30-17:15	0.005	0.029	0.024	0.038	0.014	0.029	0.014	0.028	1.0
" " 40	5	22:20-07:50	0.001	0.025	0.016	0.040	0.020	0.037	0.014	0.021	3.0
" " 41	8	23:00-05:45	0.004	0.023	0.019	0.026	0.013	0.021	0.012	0.020	3.0
" " 42	11	21:25-08:40	0.001	0.023	-	-	0.020	-	0.015	-	3.0
OVERALL AVERAGES							0.025	0.165	0.021	0.104	
STANDARD DEVIATION							0.008	0.176	0.007	0.123	

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³					Sample Time (Hrs.)	WIND	COMMENTS
I.D.	NUMBER	DESCRIPTION		T.S.P.	SO ₄ ⁼	Cl ⁻	Total Carbon	Free Carbon		DIR. & SPEED	& REMARKS
1	076	Ministry of Transport- & Communication (M.T.C.)	Sept. 30	5	2.0	0.6	2.4	0.6	24	NE	
2	077	254 Kenogami (254 K.)		57	2.0	0.9	4.6	1.6	24	5	
3	078	533 Lakeview (533 L.)		22	6.2	1.4	4.1	<0.1	24		
4	079	Agusabon Falls Camp (A.F.C.)		25	7.3	1.1	3.0	<0.1	24		
5	080	Kimberly-Clark Airfield (K.C.A.)		3	0.9	0.7	0.2	<0.1	23		
		Daily Average		22	3.7	0.9	2.8	0.5			
1	081	M.T.C.	Oct. 1	2	0.8	0.3	2.9	0.7	23	NE	
2	082	254 K.		93	1.1	0.6	-	<0.1	22	5	
3	083	533 L.		56	14.4	1.6	10.2	1.1	22		
4	084	A.F.C.		28	3.8	0.3	2.1	<0.1	21		
5	085	K.C.A.		-	-	TORN FILTER	INVALID	DATA	-		
		Daily Average		45	5.0	0.7	4.3	0.5			
1	086	M.T.C.	Oct. 2	4	0.4	0.2	3.6	1.3	24	N	
2	087	254 K.		142	8.1	1.4	4.8	0.3	24	<5	
3	088	533 L.		48	14.3	1.1	8.1	0.9	24		
4	089	A.F.C.		35	1.4	0.6	2.6	<0.1	25		

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³					Sample Time (Hrs.)	WIND	COMMENTS
I.D.	NUMBER	DESCRIPTION		T.S.P.	SO ₄ ⁼	Cl ⁻	Total Carbon	Free Carbon		DIR. & SPEED	& REMARKS
5	090	K.C.A.	Oct. 2	13	1.4	0.3	4.0	2.1	24	N ≤ 5	
		Daily Average		48	5.1	0.7	4.6	0.9			
1	091	M.T.C.	Oct. 3	31	5.2	0.3	10.6	3.2	23	N	
2	092	254 K.		67	10.5	0.9	5.4	1.2	23	≤ 5	
3	093	533 L.		28	5.4	0.3	5.4	0.3	22		
4	094	A.F.C.		44	4.7	0.3	3.2	< 0.1	22		
5	095	K.C.A.		70	4.7	0.6	17.0	2.3	22		
		Daily Average		48	6.1	0.5	8.3	1.4			
	-	M.T.C.	Oct. 4	-	-	NO SAMPLE TAKEN			-	N	
2	098	254 K.		20	4.5	0.3	3.2	< 0.1	24	≤ 5	
3	099	533 L.		21	4.4	0.4	5.7	0.8	24		
4	100	A.F.C.		10	3.0	0.3	1.8	< 0.1	24		
5	101	K.C.A.		80	15.8	1.1	8.4	2.6	24		
		Daily Average		33	6.9	0.5	4.8	0.9			
	-	M.T.C.	Oct. 5	-	-	-	-	-		SE	
2	104	254 K.		16	3.1	0.6	2.4	< 0.1	24	10	

SITE	HI-VOL	LOCATION	DATE	MICROGRAMS/m ³					Sample Time (Hrs.)	WIND	COMMENTS
I.D.	NUMBER	DESCRIPTION		T.S.P.	SO ₄ ⁼	Cl ⁻	Total Carbon	Free Carbon		DIR. & SPEED	& REMARKS
3	103	533 L.	Oct. 5	9	2.0	0.6	3.2	<0.1	24	SE	
4	102	A.F.C.		5	0.6	0.4	0.8	<0.1	24	10	
5	106	K.C.A.		7	1.4	0.6	3.9	2.1	24		
		Daily Average		9	1.8	0.6	2.6	0.6			
1	107	M.T.C.	Oct. 6	6	0.7	0.4	3.2	1.1	24	SE	
2	108	254 K.		96	7.0	0.6	4.8	0.9	24	5	
	-	533 L.		-	-	-	-	-	-	-	
4	110	A.F.C.		14	2.3	0.9	1.2	<0.1	24		
5	111	K.C.A.		26	0.4	0.6	3.6	1.7	24		
		Daily Average		36	2.6	0.6	3.2	0.9			
1	112	M.T.C.	Oct. 7	6	4.3	0.3	2.3	1.1	24	E	
2	113	254 K.		32	4.0	0.3	1.2	<0.1	24	10	
3	114	533 L.		11	4.9	0.3	1.3	<0.1	24		
4	115	A.F.C.		15	7.3	0.3	0.9	<0.1	24		
5	116	K.C.A.		8	4.1	0.3	2.2	1.1	24		
		Daily Average		14	4.9	0.3	1.6	0.5			

SITE I.D.	HI-VOL NUMBER	LOCATION DESCRIPTION	DATE	MICROGRAMS/m ³					Sample Time (Hrs.)	WIND DIR. & SPEED	COMMENTS & REMARKS
				T.S.P.	SO ₄ ⁼	Cl ⁻	Total Carbon	Free Carbon			
1	118	M.T.C.	Oct. 9	9	3.3	0.2	3.8	0.9	24	WSW	
2	119	254 K.		20	5.0	0.4	4.9	0.6	24	10	
3	120	533 L.		14	5.4	0.6	6.1	1.1	24		
4	121	A.F.C.		13	4.0	0.3	2.4	<0.1	24		
5	117	K.C.A.		48	24.9	2.6	4.6	2.6	24		
		Daily Average		21	8.5	0.8	4.3	1.1			
1	122	M.T.C.	Oct. 10	5	3.1	0.4	2.3	1.3	24	S-SW	
2	124	254 K.		54	2.7	0.3	1.0	<0.1	24	<5	Calm
3	125	533 L.		3	3.1	0.6	2.6	<0.1	24		Overall averages
4	126	A.F.C.		-	6.0	0.6	-	-	24		of TSP per site:
5	123	K.C.A.		7	4.9	0.3	3.1	1.4	24		#1 - 9 ug/m ³
		Daily Average		17	4.0	0.4	2.3	0.7			#2 - 60 " "
											#3 - 23 " "
		Overall Average		30	4.9	0.6	3.9	0.8			#4 - 21 " "
											#5 - 29 " "



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09. APPENDIX

a) Figures:

#1	TRS, SO ₂ & O ₃	Concentration/time analyses for Terrace Bay #1	
#2	"	"	#2
#3	"	"	#3
#4	"	"	#6
#5	"	"	#7
#6	"	"	#14
#7	"	"	#16
#8	"	"	#18
#9	"	"	#20
#10	"	"	#22
#11	"	"	#25
#12	"	"	#27
#13	"	"	#30
#14	NO _x , NO ₂ & NO	Concentration/time analyses For Terrace Bay #14	

b) Maps:

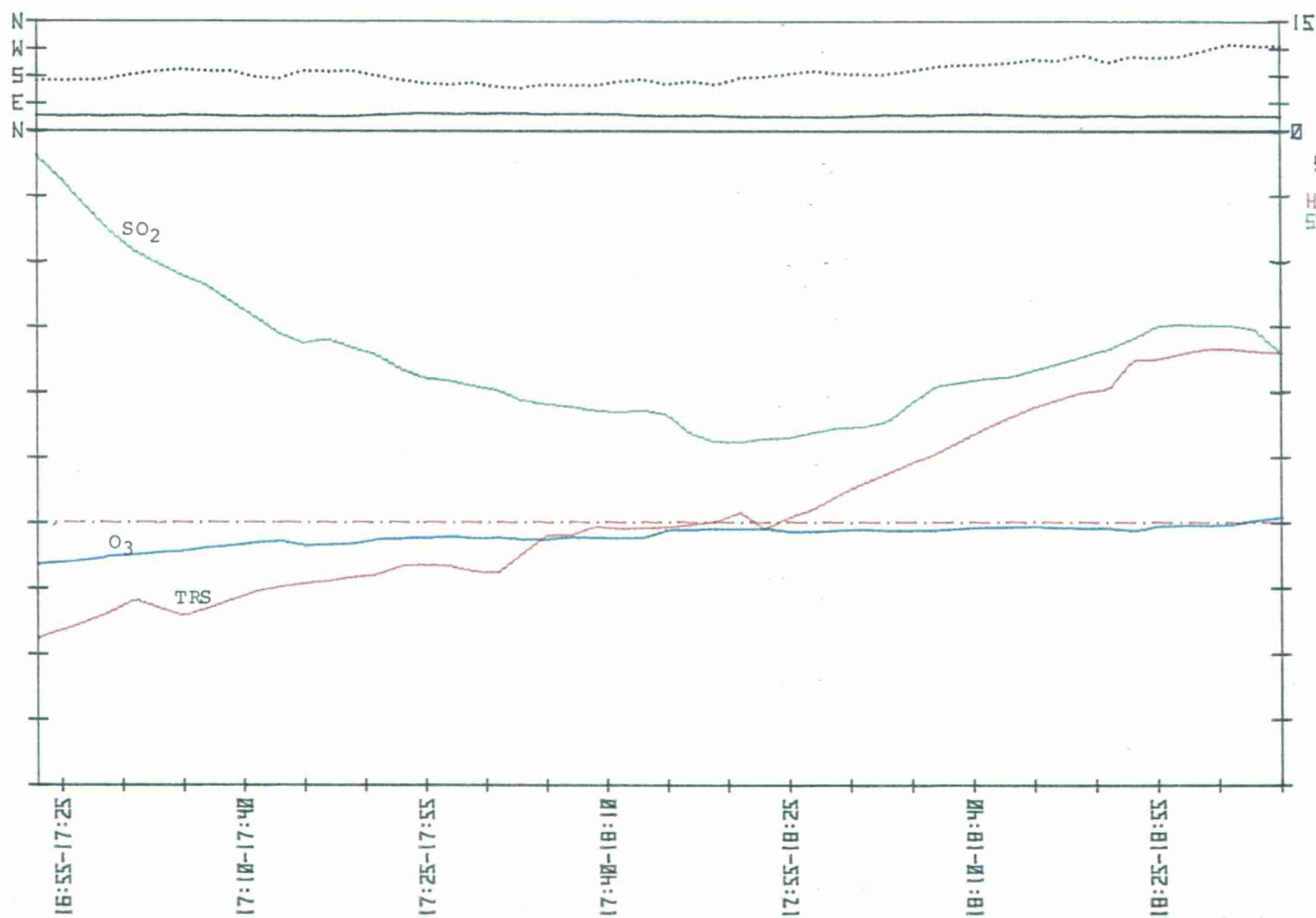
#4	TRS	Wind-Rose for Terrace Bay #3	
#5	"	"	#6
#6	"	"	#14
#7	"	"	#20
#8	NO _x	"	#2

TERRACE BAY #1

FIG. # 1

16:53 SEP 29 1977 SCAN= 120 SEC AVE= 30 MIN
BRIDGE WEST T.B. (49160-54034)/1.4 KM. 210 DGS / SOURCE

TRS
 SO2
 O3
 10⁻⁴ PPM
 10⁻³ PPM
 10⁻² PPM
 1.0
 2.0
 3.0
 4.0
 5.0
 6.0
 7.0
 8.0
 9.0
 10.0
 11.0
 12.0
 13.0
 14.0
 15.0
 16.0
 17.0
 18.0
 19.0
 20.0
 21.0
 22.0
 23.0
 24.0
 25.0
 26.0
 27.0
 28.0
 29.0
 30.0
 31.0
 32.0
 33.0
 34.0
 35.0
 36.0
 37.0
 38.0
 39.0
 40.0
 41.0
 42.0
 43.0
 44.0
 45.0
 46.0
 47.0
 48.0
 49.0
 50.0
 51.0
 52.0
 53.0
 54.0
 55.0
 56.0
 57.0
 58.0
 59.0
 60.0
 61.0
 62.0
 63.0
 64.0
 65.0
 66.0
 67.0
 68.0
 69.0
 70.0
 71.0
 72.0
 73.0
 74.0
 75.0
 76.0
 77.0
 78.0
 79.0
 80.0
 81.0
 82.0
 83.0
 84.0
 85.0
 86.0
 87.0
 88.0
 89.0
 90.0
 91.0
 92.0
 93.0
 94.0
 95.0
 96.0
 97.0
 98.0
 99.0
 100.0



W DIR---DEG
 W SPD---KM/HR
 STANDARD
 H2S 0.02 PPM
 SO2 0.30 PPM

TERRACE BAY #2

FIG. # 2

11:42 SEP 30 1977

SCAN= 30

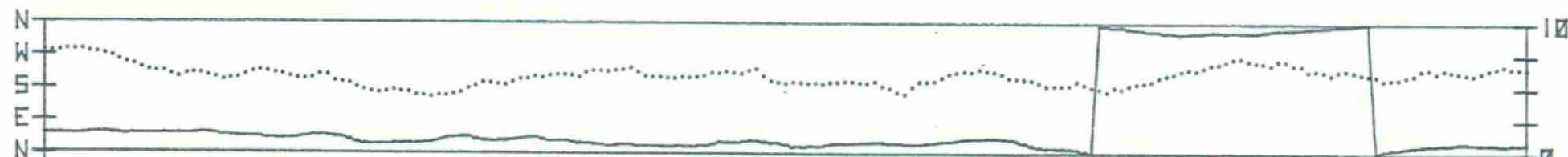
SEC

AVE= 30

MIN

BRIDGE WEST T.B. (49160-54034), 1.4 KM. 210 DEG / SOURCE

WDIR
WSPD



STANDARD

H2S 0.02 PPM
SO2 0.30 PPM

SO2
O3
TRS

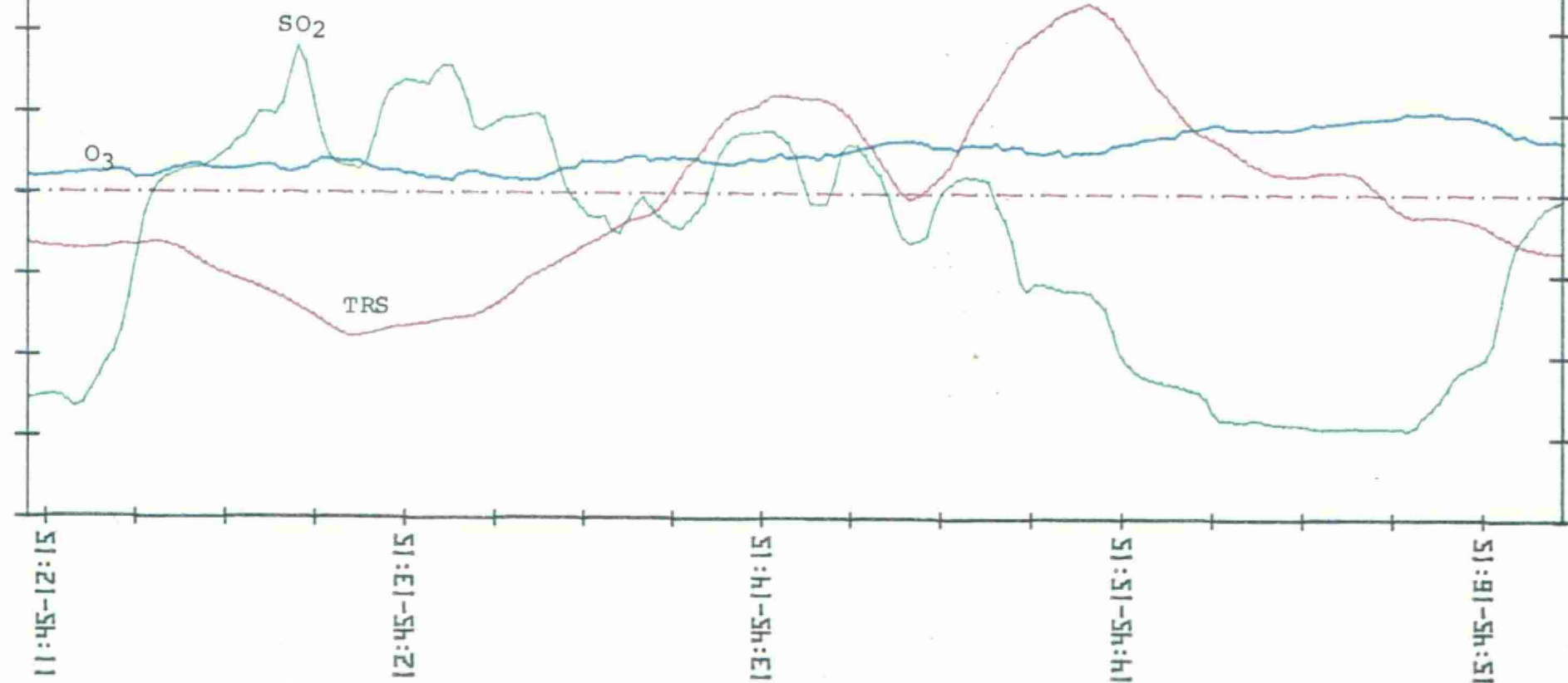
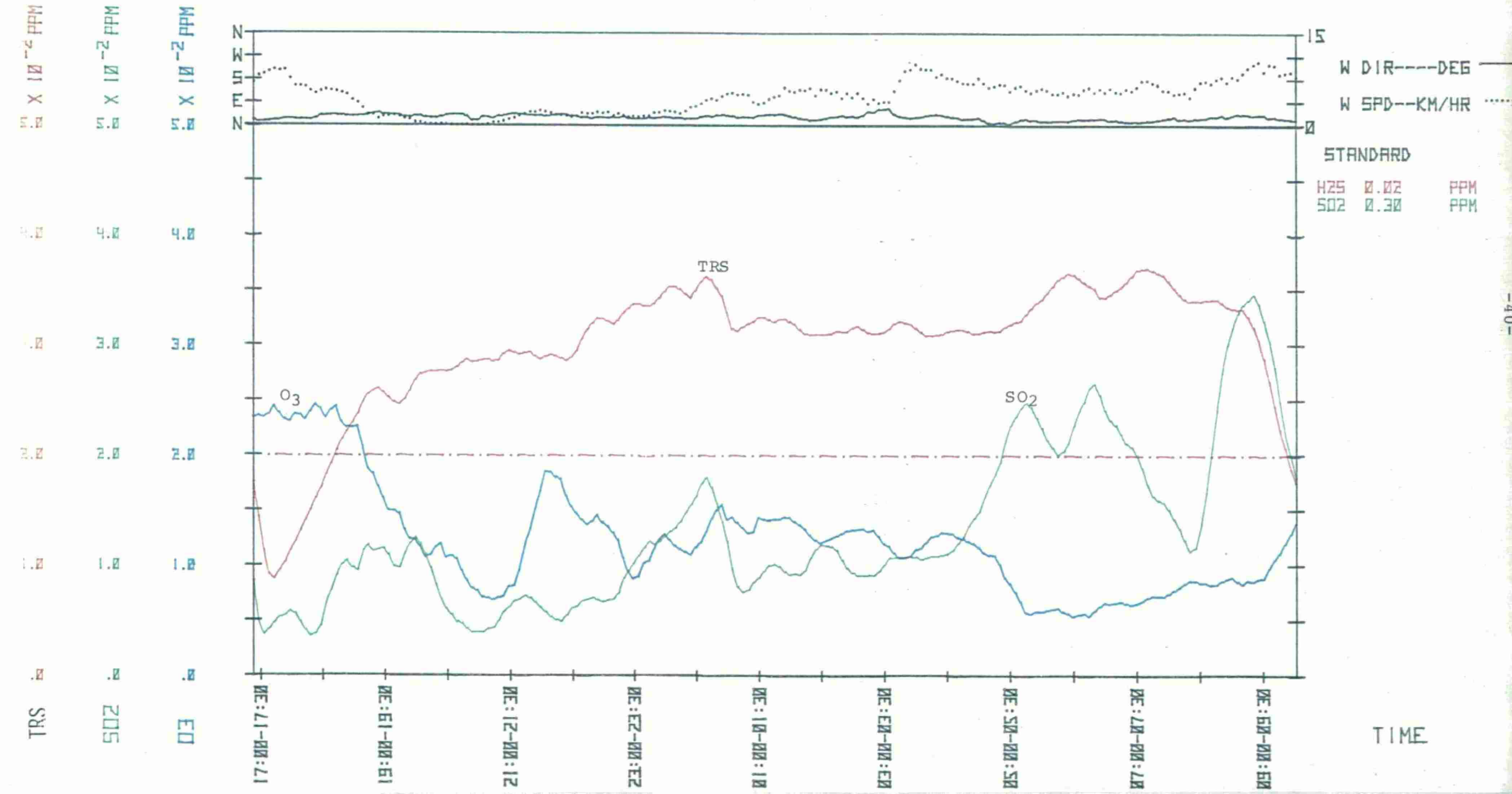


FIG # 3.

SCAN= 120 SEC

AVE= 30 MIN

BRIDGE WEST T.B., (049160-54034), 1.4 KM. 210 DEG / SOURCE



TERRACE BAY #6

FIG # 4.

14:42 OCT 1 1977

SCAN= 60

SEC

AVE= 30

MIN

HWY #17, WEST TERRACE BAY; (49120-54035), 1.6KM, 225 DEG/SOURCE

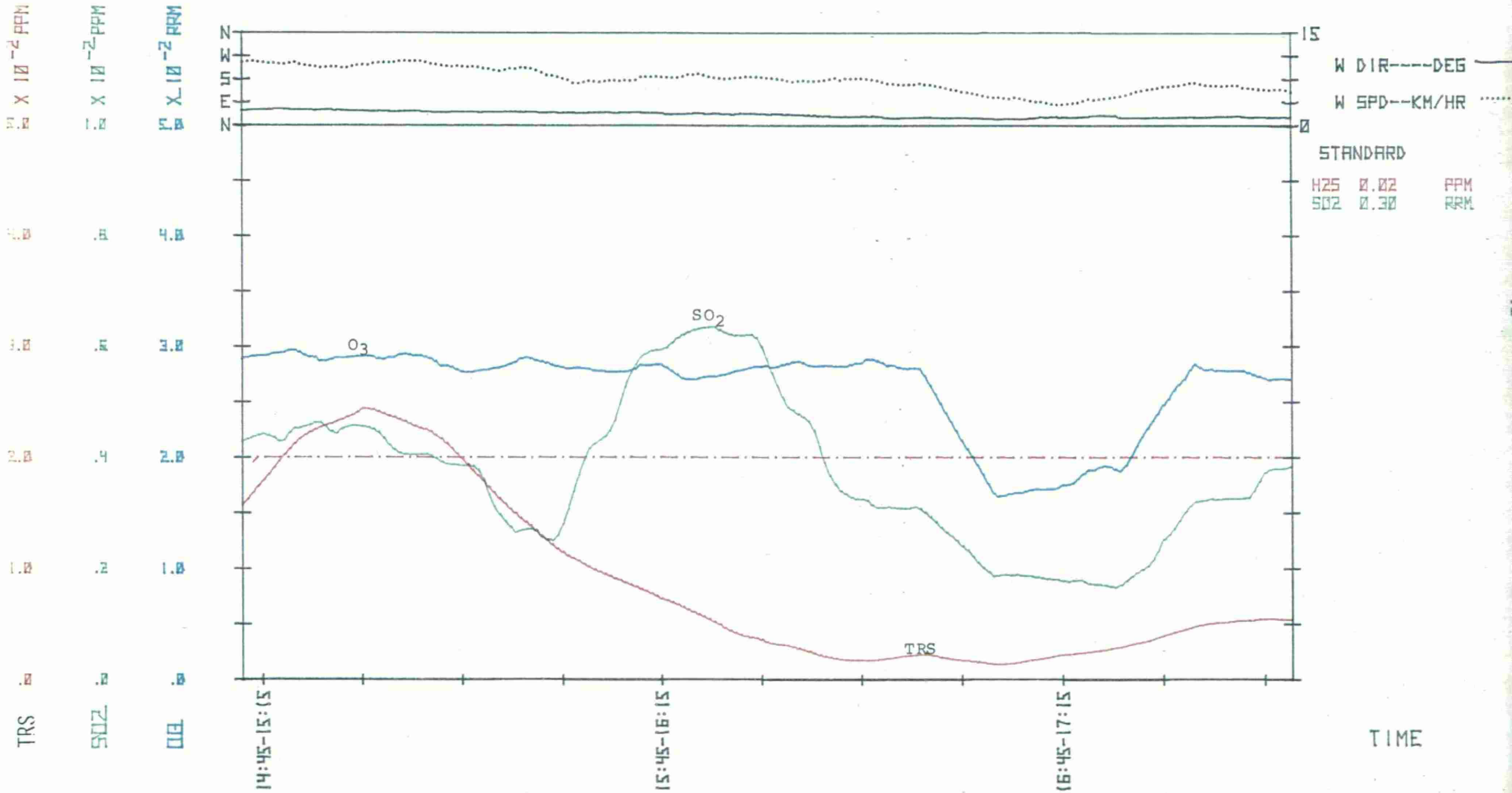
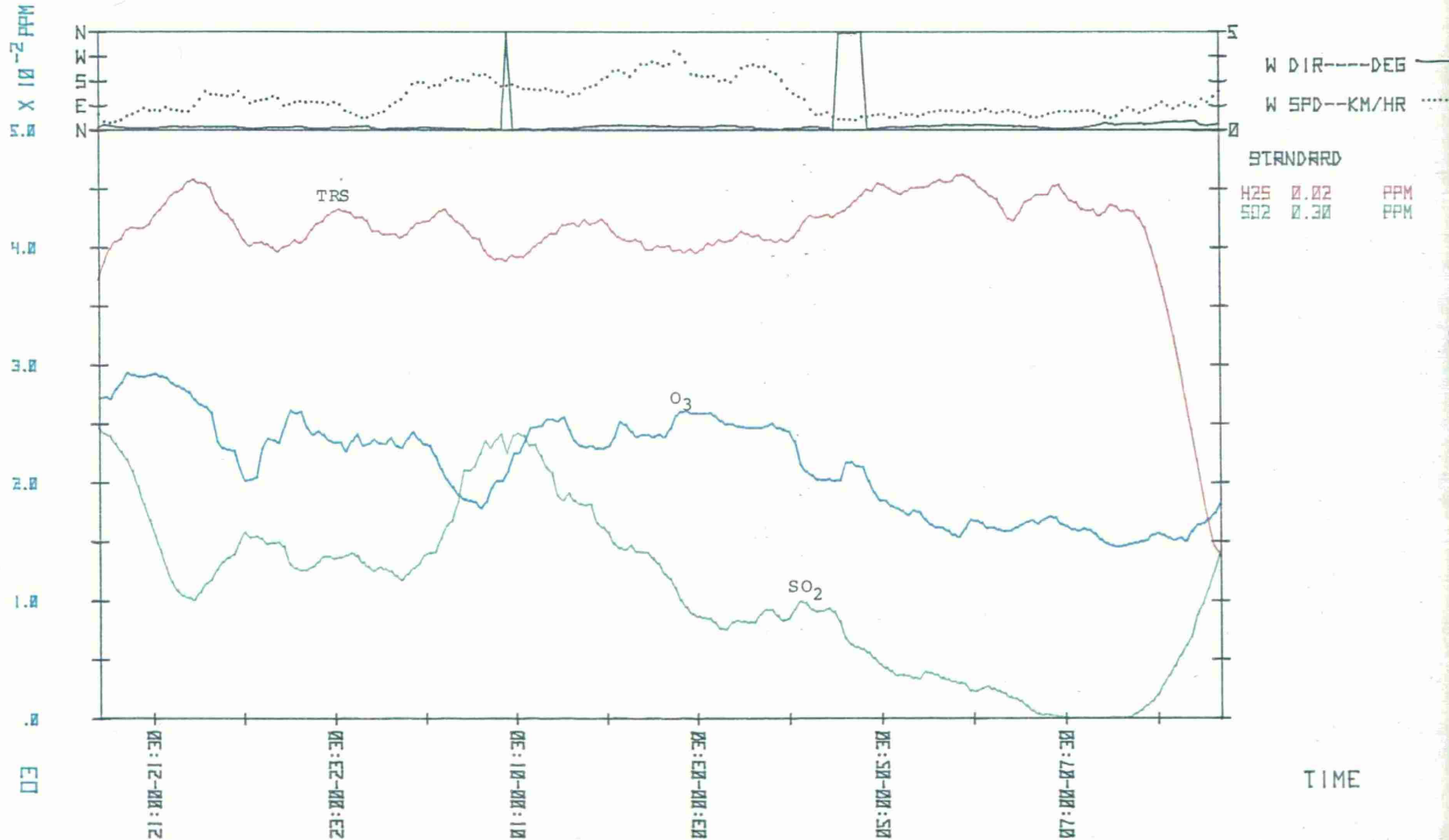


FIG # 5.

AVE= 30 MIN

HWY #17, WEST OF T.B. & BRIDGE; (49120-54035), 1.6KM, 225 DEG/SOURCE



TERRACE BAY #14

FIG # 6.

11:19 OCT 3 1977

SCAN= 60

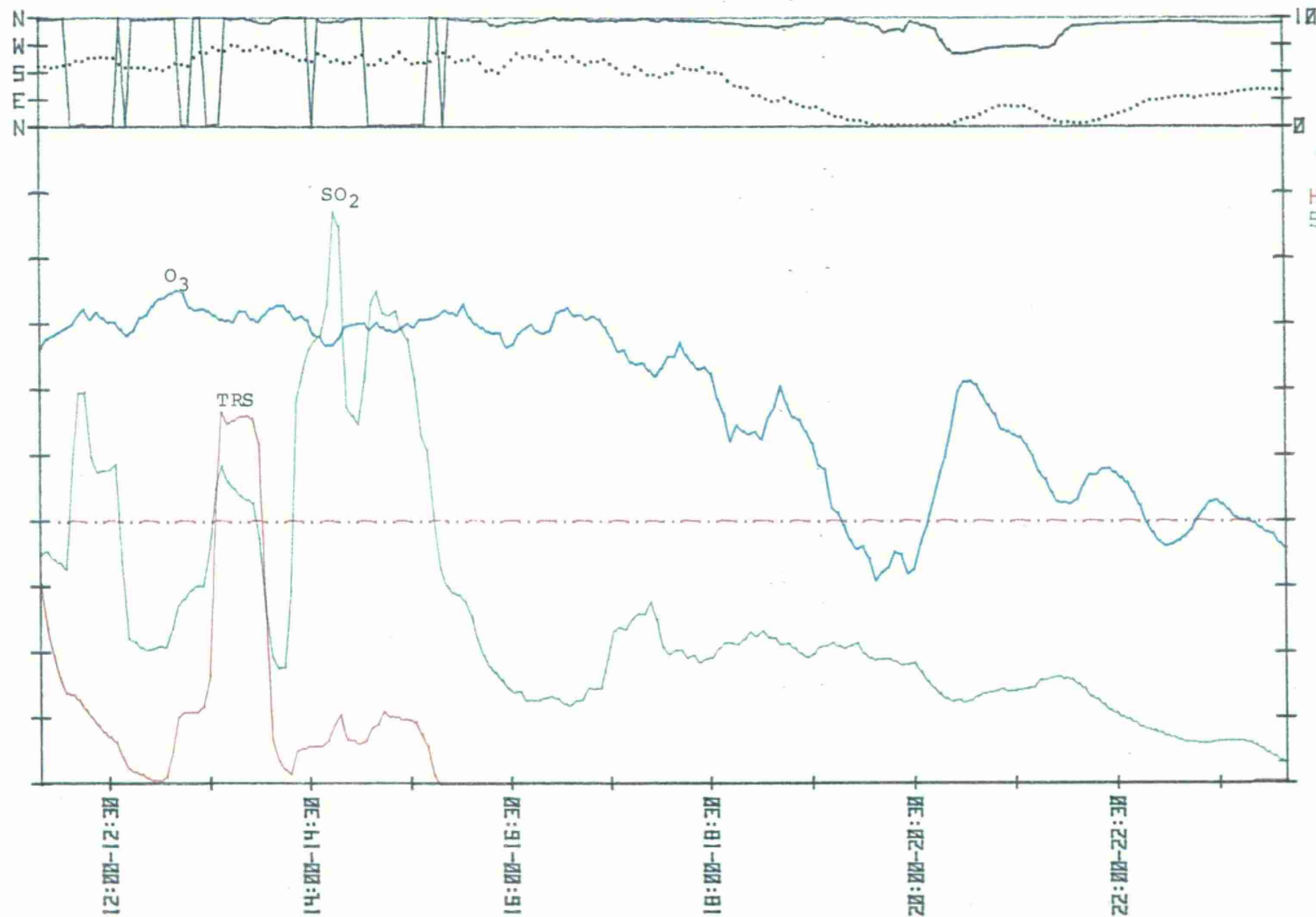
SEC

AVE= 30

MIN

#169 BIRCH STREET, (49250-54036), 1.1KM., 170 DEG/SOURCE

TRS
 SO2
 CO
 1.0
 0.8
 0.6
 0.4
 0.2
 0.0
 1.0
 0.8
 0.6
 0.4
 0.2
 0.0
 1.0
 0.8
 0.6
 0.4
 0.2
 0.0



W DIR---DEG
 W SPD---KM/HR
 STANDARD
 H2S 0.02 PPM
 SO2 0.30 PPM

TIME

TERRACE BAY #16

22:18 OCT 14 1977 SCAN= 60 SEC AVE= 30 MIN
TERRACE BAY, SHELL STATN.; (49320-54035), 1.6KM-135065/SOURCE

9	8	7	5	3	2	TEMP	DEG C
57	60	63	66	70	70	HUM	% REL
983	983	984	985	986	988	PRES	MBAR

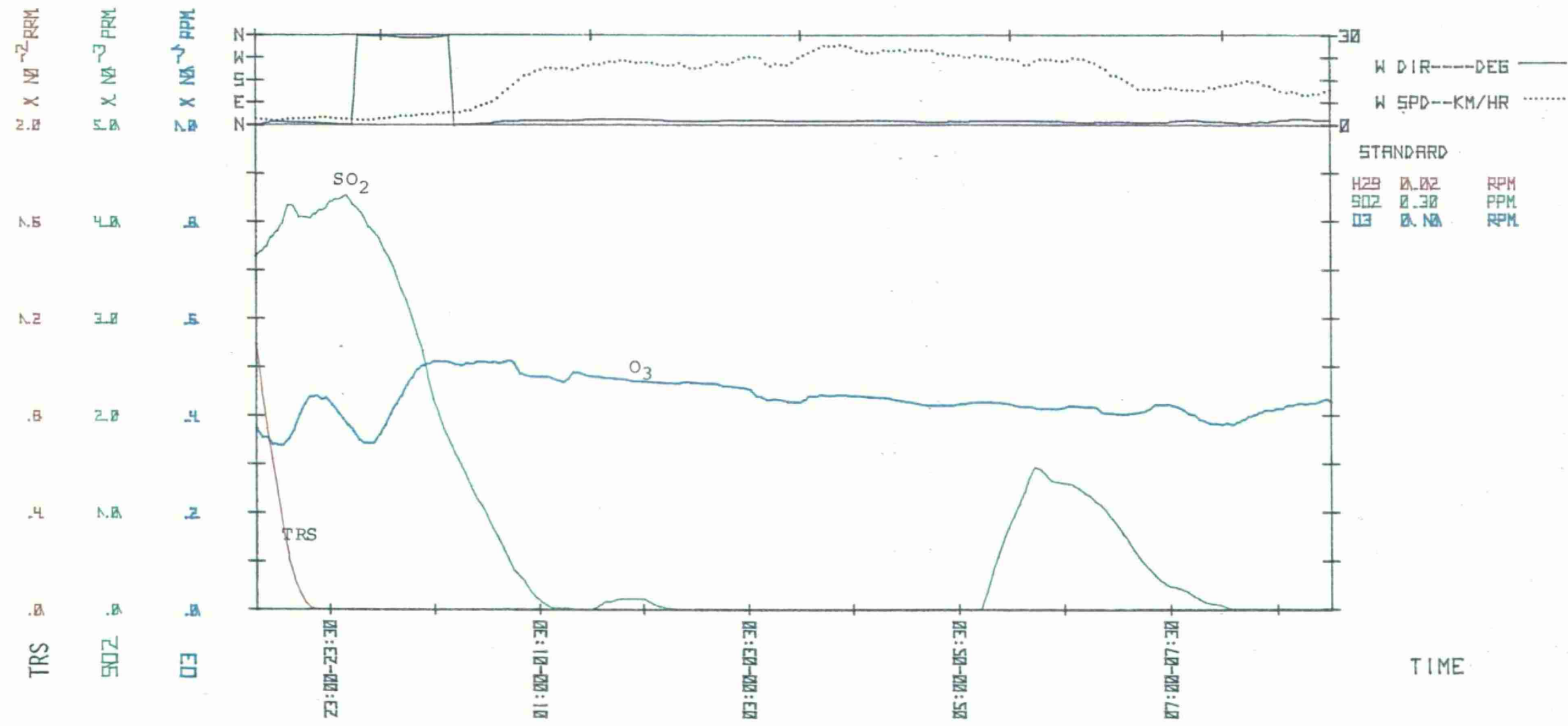


FIG # 8.

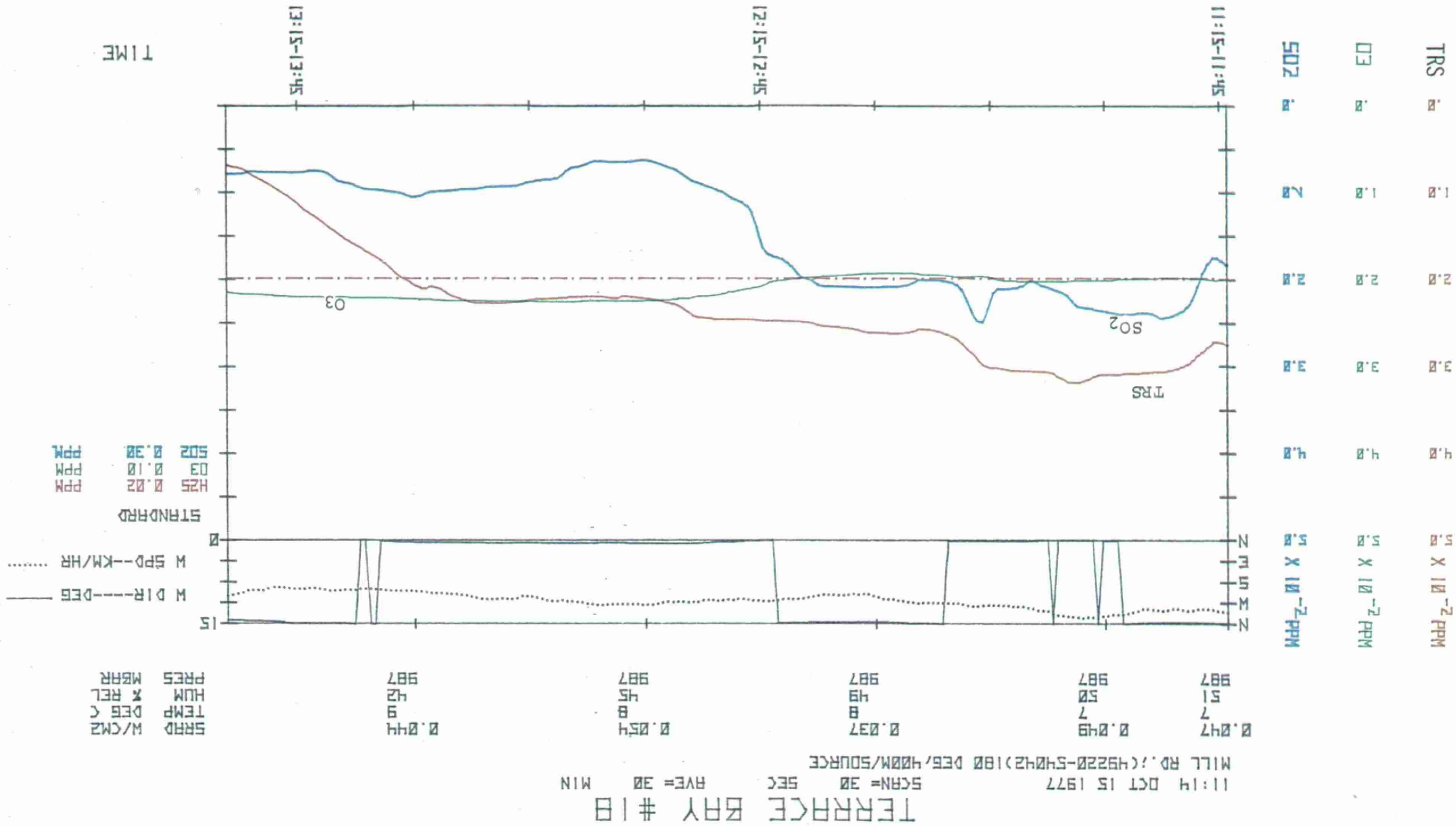


FIG. # 9.

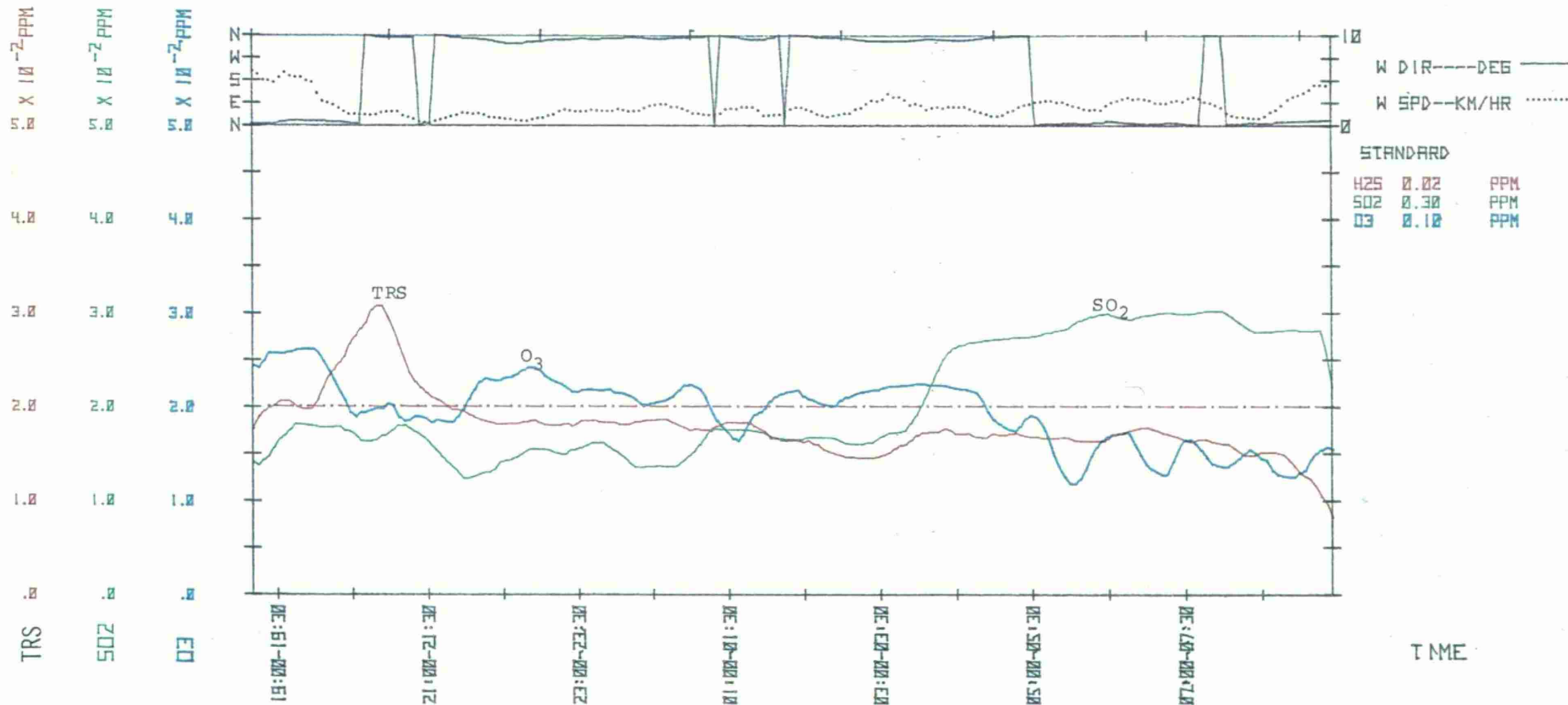
TERRACE BAY #20

NR:40 OCT 15 1977

SCAN= 120 SEC AVE= 30 MIN

TERRACE BAY SPORTS CENTRE, (49230-56030), 1.8KM, 170065/SOURCE

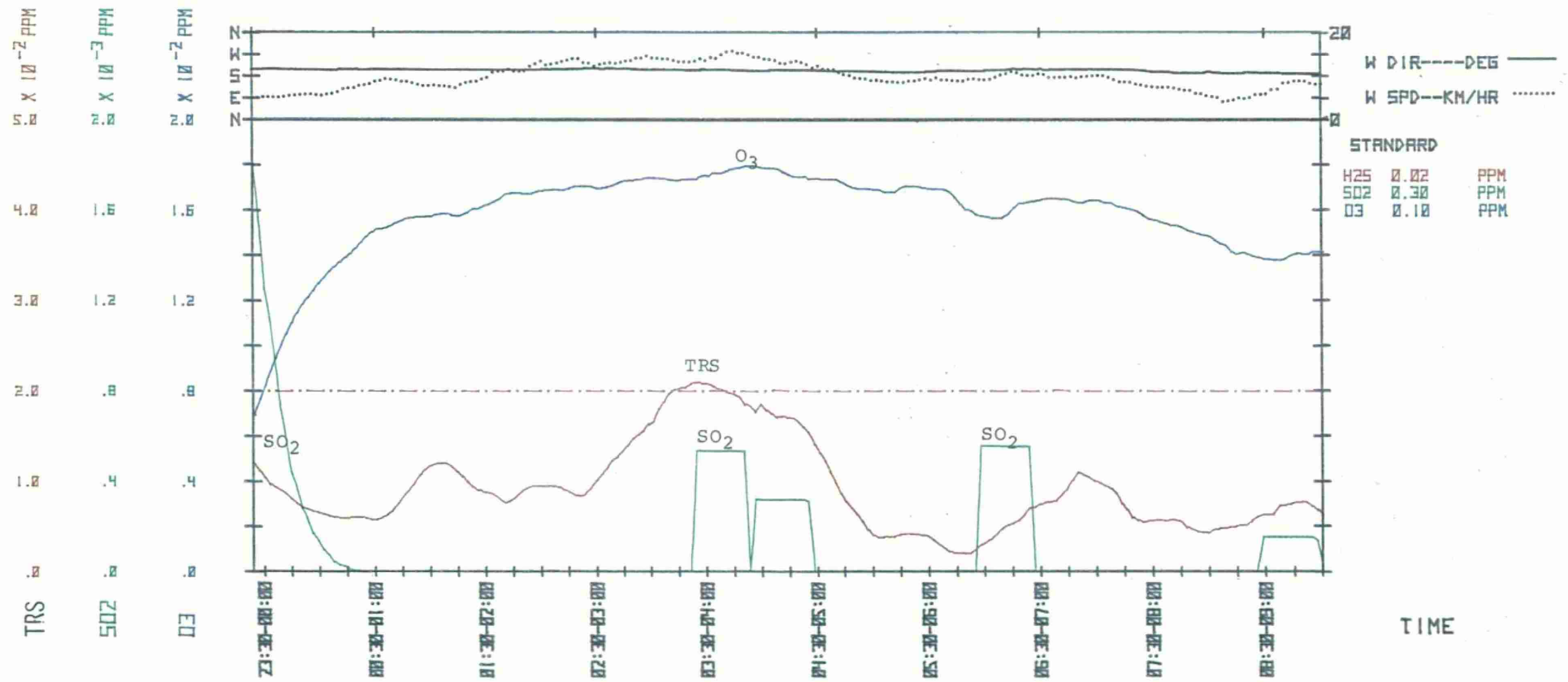
0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.005	SRAD	W/CM2
4	1	-0	-1	1	-1	-2	-2	TEMP	DEG C
38	48	62	67	62	86	87	90	HUM	% REL
989	989	989	989	989	989	989	990	PRES	MBAR



TERRACE BAY #22

23:24 OCT 16 1977 SCAN= 60 SEC AVE= 30 MIN
 CROSSING #1;(49385-54066)/2.5KM/ 50 DEG/SOURCE

0.000	0.000	0.000	0.000	0.000	0.002	SRAD	W/CM2
5	5	5	5	5	5	TEMP	DEG C
77	80	82	85	89	95	HUM	% REL
981	981	979	977	975	973	PRES	MBAR



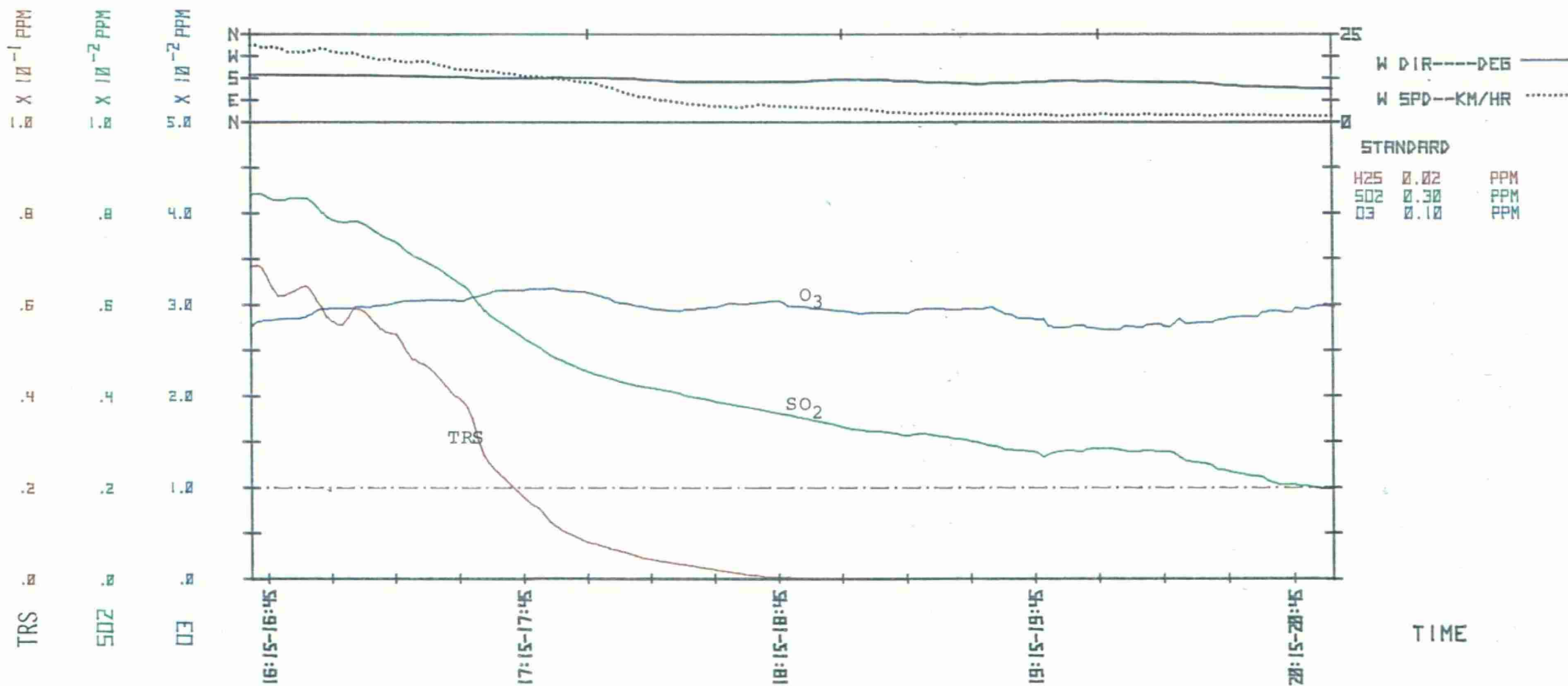
TERRACE BAY #25

16:11 OCT 17 1977

SCAN= 90 SEC

AVE= 30 MIN

MILL RD.; (49260-54058)/1.2KM, 30 DEG/SOURCE

0.022
9
79
9660.006
9
80
9660.000
9
88
9660.000
9
89
966SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR

TERRACE BAY #27

17:40 NOV 7 1977

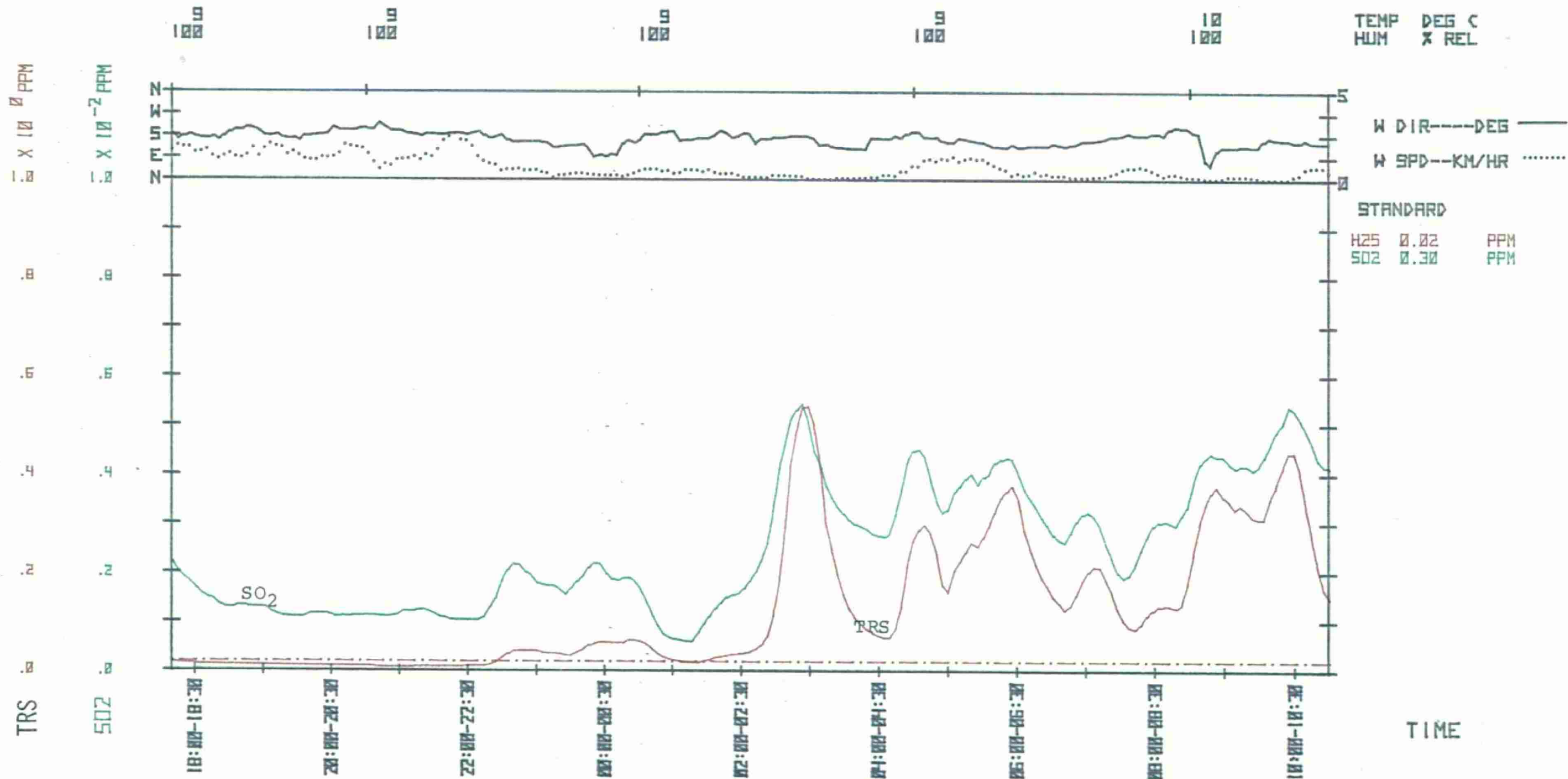
SCAN= 90

SEC

AVE= 30

MIN

TERRACE BAY CROSSING #1; (49385-54065)/2.5KM/ 40 DEG/SOURCE



TERRACE BAY #30

16:30 OCT 1 1977

SCAN= 300 SEC

AVE= 30 MIN

MILL RD NEXT TO CEMETARY (49294-54041) / .79KM / 165 DEG / SOURCE

5.0
 2.0
 5.0
 4.0
 3.0
 2.0
 1.0
 .0

X 10⁻² PPM

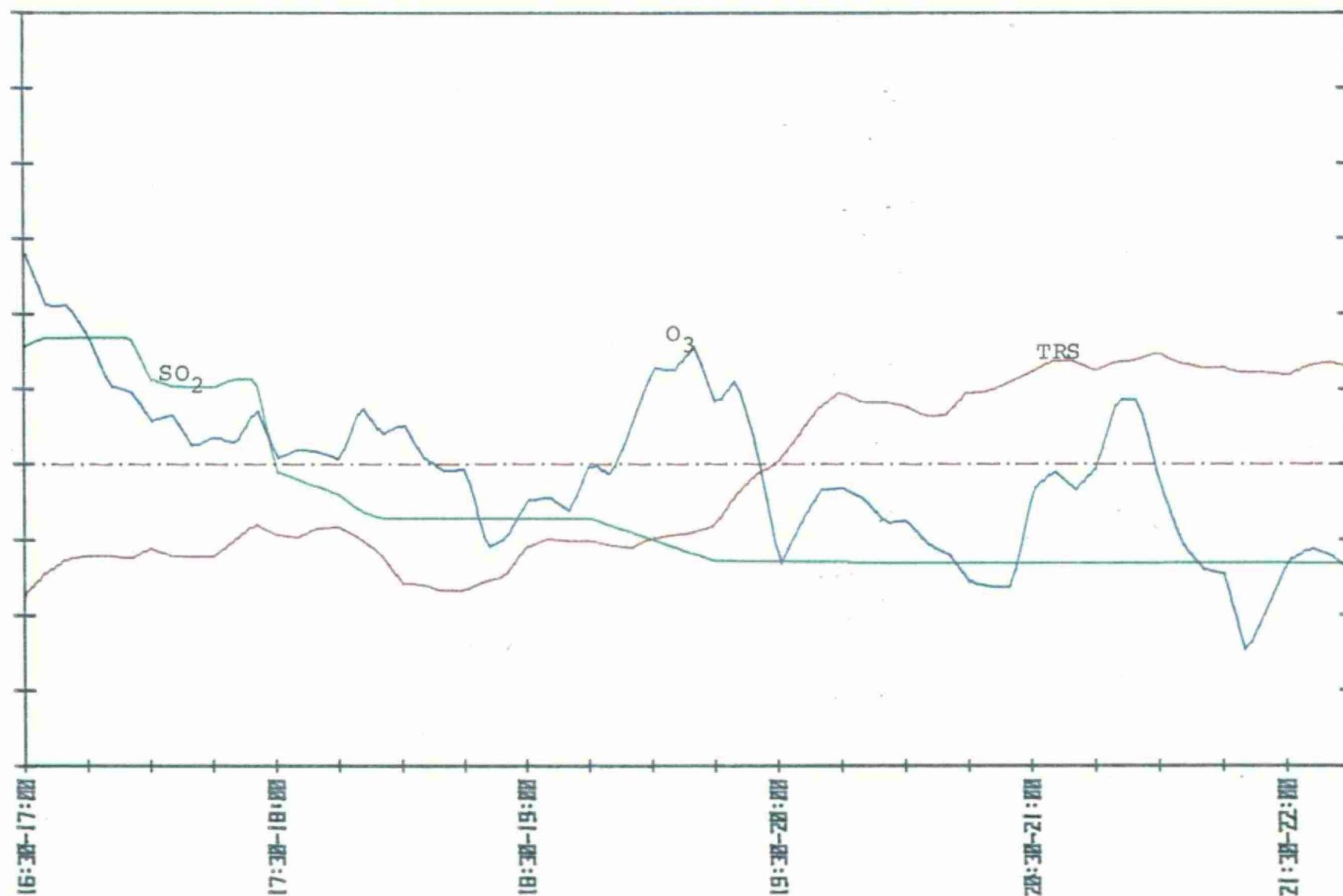
5.0
 2.0
 5.0
 4.0
 3.0
 2.0
 1.0
 .0

X 10⁻² PPM

5.0
 2.0
 5.0
 4.0
 3.0
 2.0
 1.0
 .0

X 10⁻² PPM

TRS

SO₂O₃

STANDARD

H2S	0.02	PPM
SO2	0.30	PPM
O3	0.10	PPM

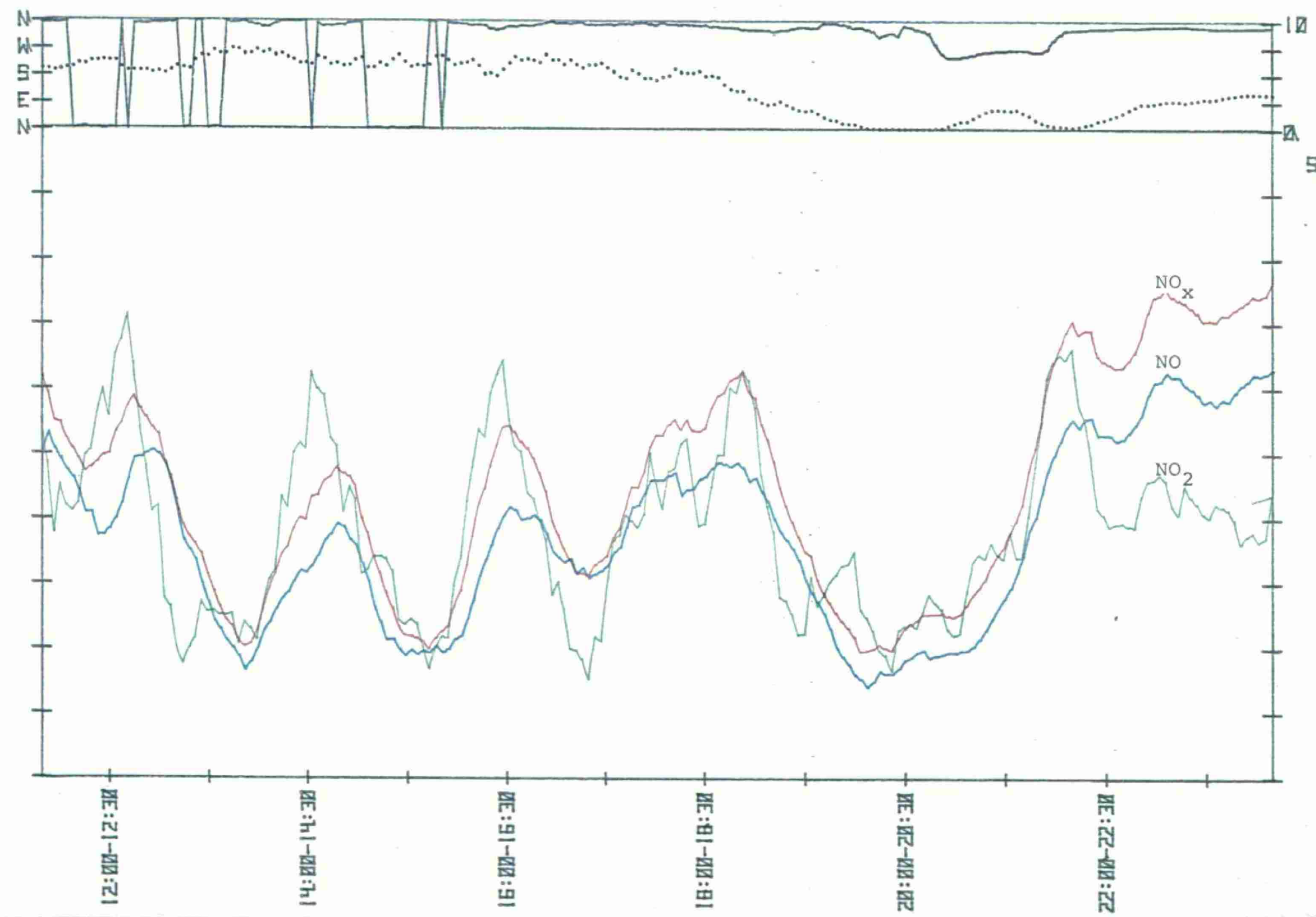
TIME

TERRACE BAY #14

FIG # 14

11:19 OCT 3 1977
 5CAN= 60 SEC AVE= 30 MIN
 #169 BIRCH STREET, (49250-54036), 1.1KM., 170 DEG/SOURCE

NOX 10⁻¹ PPM
 NO2 10⁻¹ PPM
 NO 10⁻¹ PPM



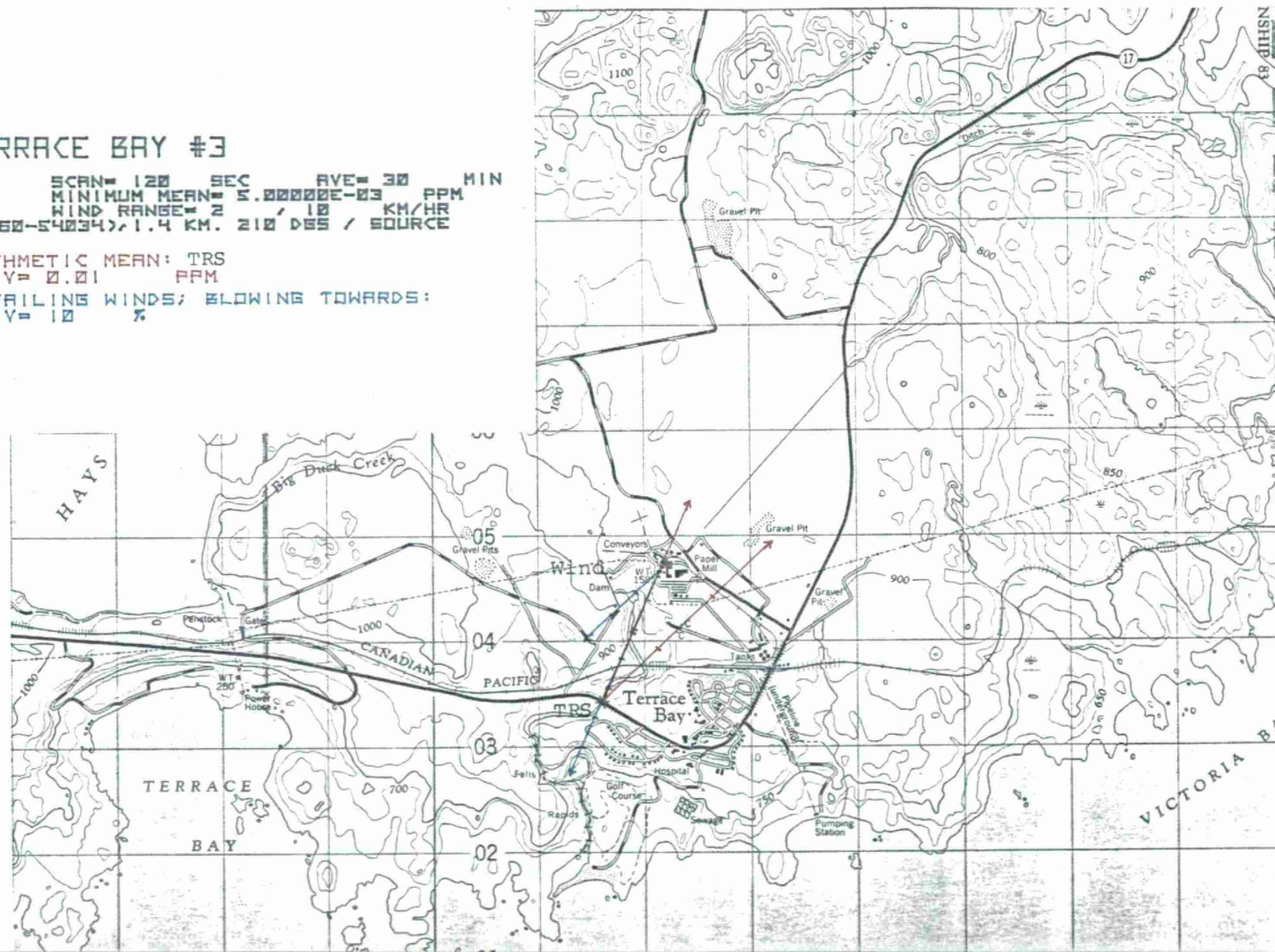
W DIR----DEG
 W SPD--KM/HR
 STANDARD

TIME

TERRACE BAY #3

16:53 SEP 30 1977 SCAN= 120 SEC AVE= 30 MIN
LENGTH= 17.1 HRS MINIMUM MEAN= 5.00000E-03 PPM
DELAY= 0 MIN WIND RANGE= 2 / 10 KM/HR
LOC: BRIDGE WEST T.B., (49160-54034), 1.4 KM. 210 DEG / SOURCE

```
ARITHMETIC MEAN: TRS
1 DIV= 0.01 FPM
PREVAILING WINDS; BLOWING TOWARDS:
1 DIV= 10 %
```

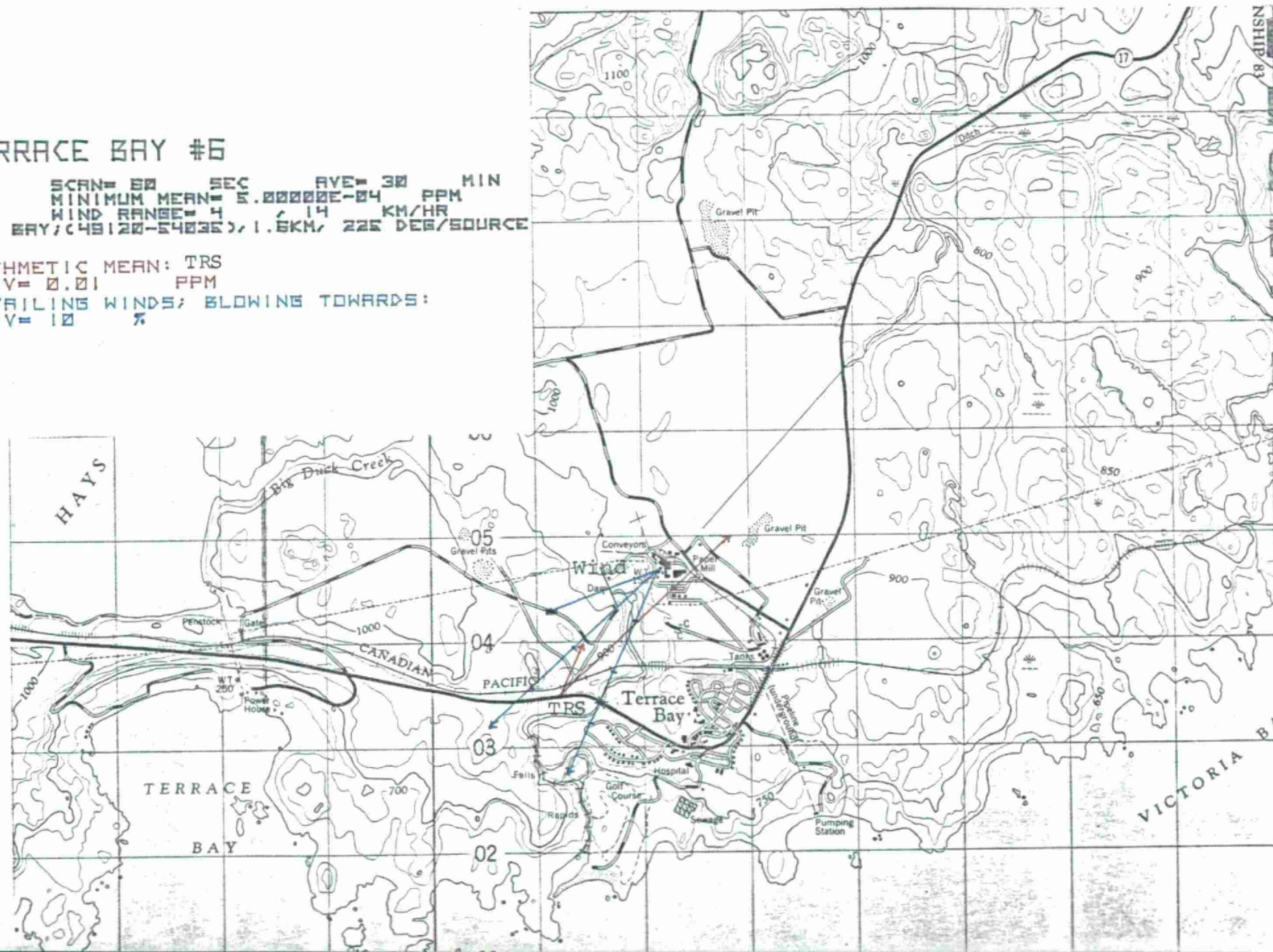


TERRACE BAY #6

14:42 OCT 1 1977
 LENGTH= 3.1 HRS
 DELAY= 0 MIN
 LOC: HWY #17, WEST TERRACE BAY; (49120-54035), 1.6KM, 225 DEG/SOURCE

SCAN= 60 SEC AVE= 30 MIN
 MINIMUM MEAN= 5.00000E-04 PPM
 WIND RANGE= 4 / 14 KM/HR

ARITHMETIC MEAN: TRS
 1 DIV= 0.01 PPM
 PREVAILING WINDS; BLOWING TOWARDS:
 1 DIV= 10 %



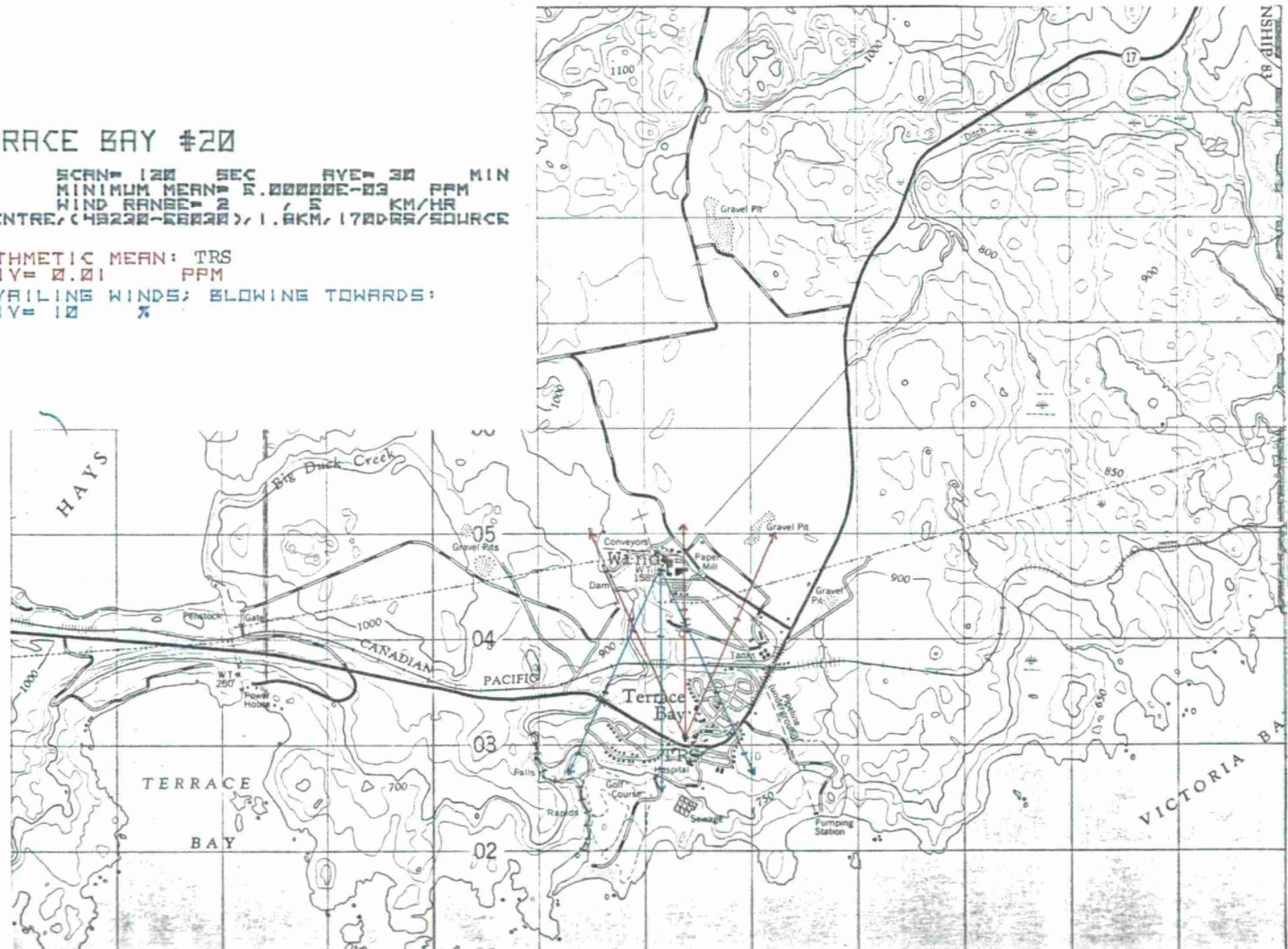
TERRACE BAY #20

18:40 OCT 15 1977 SCAN= 120 SEC AVE= 30 MIN
LENGTH= 14.7 HRS MINIMUM MEAN= 5.00000E-03 PPM
DELAY= 0 MIN WIND RANGE= 2 / 5 KM/HR
LOC: TERRACE BAY SPORTS CENTRE, (49220-58820), 1.8KM, 1700PS/SOURCE

```

ARITHMETIC MEAN: TRS
1 DIV= 0.01 PPM
PREVAILING WINDS: BLOWING TOWARDS:
1 DIV= 10 %

```



TERRACE BAY #2

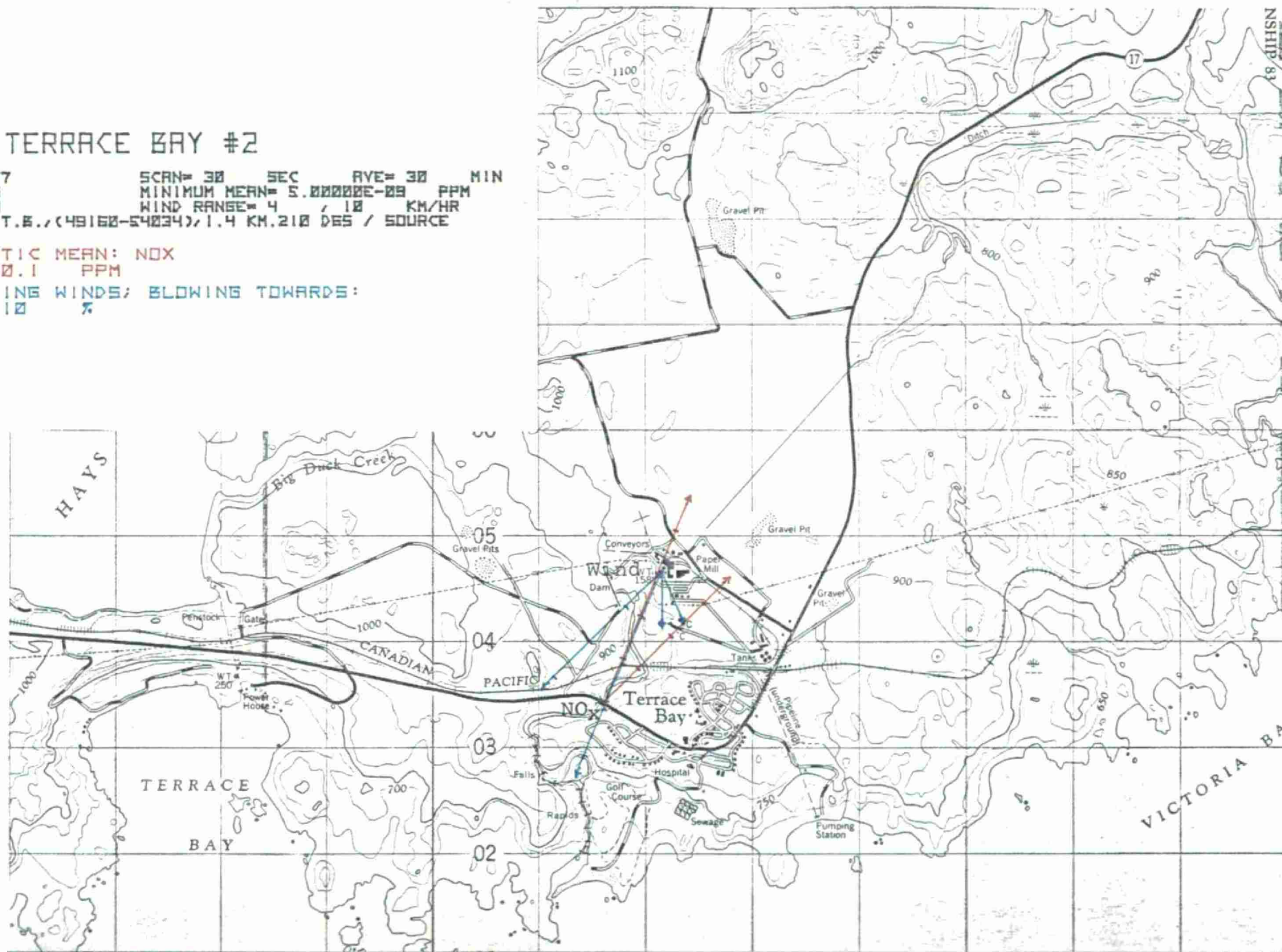
11:42 SEP 30 1977
 LENGTH= 4.7 HRS
 DELAY= 0 MIN
 LOC: BRIDGE WEST T.B. (49160-54034) 1.4 KM.210 DES / SOURCE

ARITHMETIC MEAN: NOX

1 DIV= 0.1 PPM

PREVAILING WINDS: BLOWING TOWARDS:

1 DIV= 10 %





(8133)

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